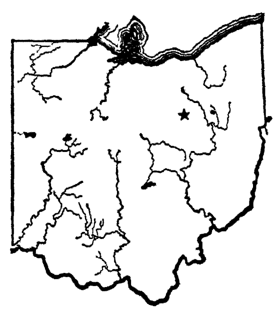
THE MINERAL METABOLISM OF THE MILCH COW

SECOND PAPER

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., JANUARY, 1917

BULLETIN 308



OHIO AGRICULTURAL EXPERIMENT STATION

STATION STAFF

Charles E. Thorne, M. S. A., *Director*
C. G. Williams, *Associate Director*

DEPARTMENTAL ORGANIZATION

ADMINISTRATION
The Director, *Chief*
William H. Kramer, *Bursar*
W. K. Greenbank, *Librarian*
L. L. Rummell, B. S., *Editor*
F. M. Lutts, *In Charge of Exhibits*
W. J. Holmes, *Printer*
Dora Ellis, *Mailing Clerk*
E. J. Houser, *Photographer*
Glenn Hall, *Engineer*

AGRONOMY
C. G. Williams, *Chief*
F. A. Welton, M. S., *Associate*
William Holmes, *Farm Manager*
C. A. Patton, *Assistant*
C. A. Gearhart, B. S., *Assistant*
E. C. Morr, *Office Assistant*
C. H. Lebold, *Asst. Foreman*

ANIMAL HUSBANDRY
B. E. Carmichael, M. S., *Chief*
J. W. Hammond, M. S., *Associate*
Don C. Mote, M. S, *Assistant*
W. J. Buss, *Assistant*
W. L. Robison, B. S., *Assistant*
D. G. Swanger, B. S., *Assistant*
Anthony Russ, *Herdsman*
E. C. Schwan, *Shepherd* (Carpenter)

BOTANY
A. D. Selby, B. S., *Chief*
True Houser, B. S., *Asst.* (Germantown)
F. K. Mathis, *Office Assistant*
D. C. Babcock, A. B., *Assistant*
Richard Walton, B. S., *Assistant*
J. G. Humbert, B. S., *Assistant*
Wayne Van Pelt, B. S., *Assistant*

CHEMISTRY
J. W. Ames, M. S., *Chief*
Geo. E. Boltz, B. S., *Assistant*
J. A. Stenius, B. S., *Assistant*
C. J. Schollenberger, *Assistant*
Mabel K. Corbould, *Assistant*
T. E. Richmond, M. S., *Assistant*
R. R. Barker, B. S., *Assistant*

CLIMATOLOGY
C. A. Patton, *Observer*

DAIRYING
C. C. Hayden, M. S., *Chief*
A. E. Perkins, M. S., *Assistant*
R. I. Grady, B. S., *Assistant*
W. E. Vordermark, *Office Assistant*

ENTOMOLOGY
H. A. Gossard, M. S., *Chief*
J. S. Houser, M. S. A., *Associate*
W. H. Goodwin, M. S., *Assistant*
R. D. Whitmarsh, M. S., *Assistant*
J. L. King, M. S., *Assistant*

FORESTRY
Edmund Secrest, B. S., *Chief*
J. J. Crumley, Ph. D., *Assistant*
A. E. Taylor, B. S., *Assistant*
J. W. Calland, B. S., *Assistant*
D. E. Snyder, *Office Assistant*

HORTICULTURE
W. J. Green, *Vice Director, Chief*
F. H. Ballou, *Assistant* (Newark)
Paul Thayer, M. S., *Assistant*
C. W. Ellenwood, *Office Assistant*
Ora Flack, *Foreman of Orchards*
W. E. Bontrager, *Foreman of Grounds*
C. G Laper, *Foreman of Greenhouses*
J. B. Keil, *Orchard Assistant*
S. N. Green, *Garden Assistant*

NUTRITION
E. B. Forbes, Ph. D., *Chief*
J. O. Halverson, Ph. D., *Assistant*
L. E. Morgan, M. S, *Assistant*
S. N. Rhue, B. S., *Assistant*
C. E. Mangels, A. M., *Assistant*

SOILS
The Director, *Chief*
C. G. Williams, *Associate in soil fertility investigations*
J. W. Ames, M. S., *Asso. in soil chemistry*
E. R. Allen, Ph. D., *Asso. in soil biology*
B. S. Davisson, M. A., *Assistant*
A. Bonazzi, B. Agr., *Assistant*
W. C. Boardman, B. S., *Assistant*
Oliver Gossard, B. S., *Assistant*
Olin H. Smith, B. S., *Assistant*
H. J. Conlin, B. Chem., *Assistant*
G. K. Sivaslian, B. S., *Assistant*

FARM MANAGEMENT
C. W. Montgomery, *Chief*
H. L. Andrew, B. S., *Assistant*

District Experiment Farms

Northeastern Test-Farm, Strongsville
J. Paul Markley, *Resident Manager*

Southwestern Test-Farm, Germantown
Henry M. Wachter, *Resident Manager*

Southeastern Test-Farm, Carpenter
H. D. Lewis, *Resident Manager*

Northwestern Test-Farm, Findlay
John A. Sutton, *Resident Manager*

County Experiment Farms

Miami County Experiment Farm, Troy
Geo. R. Eastwood, B. S., *Agent in Charge*

Paulding County Experiment Farm, Paulding
H. A. Ray, *Foreman*

Clermont Co. Experiment Farm, Owensville
S. B. Stowe, B. S., *Agent in Charge*

Hamilton Co. Experiment Farm, Mt. Healthy
D. R. Van Atta, B. S., *Agent in Charge*

Washington County Experiment Farms, Fleming and Marietta

Mahoning Co. Experiment Farm, Canfield
M. O. Bugby, B. S., *Agent in Charge*

Trumbull Co. Experiment Farm, Cortland
M. O. Bugby, B. S., *Agent in Charge*

CONTENTS

BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 308 JANUARY, 1917

THE MINERAL METABOLISM OF THE MILCH COW

SECOND PAPER

E. B. FORBES, F. M. BEEGLE, C. M. FRITZ, L. E. MORGAN
AND S. N. RHUE

No human food is more nearly indispensable than is cow's milk. It is important, therefore, to know all the facts regarding the physiology of milk production, regardless of present economic bearings.

As we have previously observed, the milch cow is remarkable, among farm animals, for the rapidity with which she produces proteid and mineral nutriment in her milk, the unusual protein requirement of the cow being fully understood, but her mineral requirements having received scant recognition.

Our first study of the mineral metabolism of the milch cow[1] established facts of consequence which, previously, had hardly been suspected. It had been our belief that all animals which receive leafy forage as a considerable part of the ration consume and digest as much of the mineral nutrients as required by maximum functional activities. The prevalence of this belief among practical and scientific students of animal production appears scarcely to have been affected by the existence in the literature of pathology of many hundreds of reports of malnutrition of the bones of just such animals. This malady has been considered as due to very unusual conditions of feeding; and its common occurrence has not been generally understood to have a significant bearing on normal practice in milk production.

The most important result of our earlier study of this subject was a demonstration of the fact that ordinarily liberal milk production, on common practical winter rations, fed in quantities sufficient to maintain the live weight and to cause regular protein storage, involves consistent losses of calcium, magnesium and phosphorus

[1] Ohio Agr. Exp. Sta Bul. 295, The Mineral Metabolism of the Milch Cow (1916).

from the cows' skeletons. This conclusion was based on 18 agreeing balances of income and outgo. Changes in the rations, which served greatly to increase the intake of these elements, caused but slight reduction of the losses from the body. An especially limited utilization of the minerals, on the plane of profitable milk production, thus became apparent.

OBJECTS OF THE EXPERIMENT

The objects of our second study, therefore, were to learn whether mineral equilibrium can be maintained on rations containing the maximum amounts of mineral nutriment obtainable in common practical feeds, and to determine the effects of large additions to these rations of calcium, magnesium and phosphorus in supplemental form, as inorganic salts; also to ascertain the reason for the limited utilization of the mineral nutrients during ordinarily liberal food consumption.

METHOD OF EXPERIMENTATION

The method of this study, as of the preceding one, involved the complete chemical accounting for food, milk, urine and feces. Details of procedure were as in the published report of the earlier work. Six Holstein cows were used, in collection periods of 20 days, separated by 10-day intervals on the ration of the collection period to follow. The cows were all in their second, third or fourth period of lactation. None were bred during this experiment. Had they been bred, according to the usual practice, mineral requirements would have been increased, and negative mineral balances, in all probability, would also have been more extensive. They were fed and milked four times daily, at 6-hour intervals. There was no refused feed to analyze. The milk yield varied from 38.7 to 58.35 pounds per head and day, with an average production of 47.15 pounds. The conduct of this experiment required full time from 17 men, in addition to the general oversight of the head of the department.

RATIONS

In order to attain the desired ends—maximum contents of calcium, magnesium and phosphorus—all rations were based on a leguminous roughage (either clover or alfalfa hay), corn silage, cottonseed meal, linseed oilmeal and wheat bran, all of which are rich in mineral nutriment. Cornmeal was used as the principal source of carbohydrate, but contributed comparatively little mineral substance.

In Period I, Cows 2, 3 and 4 received alfalfa hay; the others, clover. Otherwise the rations were compounded from the same feeds. In Period II, Cows 2, 3 and 4 were given a double allowance of salt, with the idea in mind that deficiency of salt in the rations of the year before might possibly have restricted the digestion of calcium, magnesium and phosphorus by limiting the supply of hydrochloric acid in the gastric juice. In this period the rations were further varied by giving calcium carbonate to Cows 5 and 6, and bone flour to Cows 1 and 4. This bone flour, which was supplied by Hirsch, Stein & Company of Chicago, is the bone-dust formed during the grinding of bones into meal for fertilizing purposes. The fat is previously extracted from the bones with naphtha, and the nitrogenous substance is removed by alternate steam digestion and hot-water treatments.

RESULTS OF THE EXPERIMENT

Table I, page 463, exhibits the average daily amounts of foods consumed, and of milk produced; also the live weights of the cows. The milk production was high, for common cows. The cows were comparatively small for Holsteins. They weighed from 1,167 to 890 pounds at the beginning of the experiment. During the course of the investigation the cows gained in weight in six cases and lost in weight the same number of times, the losses slightly exceeding the gains.

Table II, page 464, sets forth the analyses of the feeds. Among the notable details of composition are the very high calcium contents of the clover and alfalfa hay, the low calcium content of the corn, the high silicon content of the linseed oilmeal, and the high sodium and chlorine contents of the alfalfa.

Table III, page 465, shows that there were no noticeable effects of the foodstuffs or mineral supplements (sodium chloride, calcium carbonate and bone flour) on the composition of the milk.

Table IV, page 466, records the amounts of the daily rations. The food consumption was maintained without change, from day to day, during each collection period; and all foods weighed to the cows were eaten without waste. As is usual in such experiments it was necessary to depart, in certain particulars, from our plan of feeding, in order to maintain the cooperation of some of the cows. Cow No. 2 demanded especial consideration in the composition of her ration. It was necessary to feed this cow a much larger proportion of roughage to concentrates than was given to other individuals. This fact accounts for the high mineral content of the rations fed to Cow 2.

Tables V, VI and VII, on pages 467 to 469, record the amounts of the constituents in the average daily milk, urine and feces.

Tables VIII and IX, pages 470 and 471, set forth the balances of the mineral nutrients and of nitrogen. As is indicated by the headings of the columns, the groups of figures within the squares signify (reading downward) food, milk, urine and feces. The fourth column of the tables states the characteristic or distinguishing features of the somewhat complicated rations.

The intake of sodium and of chlorine was prominently affected by the alfalfa hay, which was rich in these elements, and also by the amount of common salt fed. Salt was allowed in the amount of 28 grams per head and day, except in Period II, when Cows 2, 3 and 4 received double the usual amount, that is, 56 grams.

In Period I, Cows 2, 3 and 4 received from 20.077 to 25.638 grams of sodium per day, and stored from 4.254 to 9.140 grams per day, of this element. In Period II, with an intake of sodium about 50 percent greater than in Period I, two of these cows lost sodium while the other one gained but a very small amount. Cows 2 and 4, which had stored the most sodium in Period I, lost sodium in Period II; while Cow 3, which stored the least in Period I, gained a very little in Period II.

These data show that the sodium intake of Cows 2, 3 and 4 in Period I was more than sufficient, and that in Period II it was excessive, the negative balances representing not deficiency but the throwing off of previously absorbed stores.

With a sodium intake of between 12 and 13 grams per day, in both periods, Cows 1, 5 and 6 retained sodium in three cases and lost sodium in three others, the gains very slightly exceeding the losses.

We may say, then, from the results with Cows 1, 5 and 6 in the two periods, that with cows producing about 45 pounds of milk daily, 28 grams (one ounce) of salt per head daily adds just about enough sodium to rations of ordinary feeds to provide for sodium equilibrium, though Cows 2, 3 and 4 retained considerable amounts of sodium when only one ounce of salt was fed per day, since these cows received alfalfa hay, which was very much richer in sodium than was the clover hay fed to Cows 1, 5 and 6 in both periods.

The feeding of 56 grams (two ounces) of salt per day to Cows 2, 3 and 4 in Period II, tells us nothing about sodium requirements, since it happened that these cows had stored sodium in abundance in the previous period when only 28 grams of salt was fed.

In gauging the salt fed according to the milk produced, we may consider that 10 grams of salt contains as much sodium as 25 pounds of milk, and that an ounce of salt contains as much sodium as 70 pounds of milk. An allowance of one to two ounces of salt per day, in accord with the amount of milk produced will cover all sodium requirements.

In connection with the sodium balances we naturally consider those of chlorine, since sodium and chlorine are taken in the food mostly combined as common salt. Nine of the twelve chlorine balances are negative. Even with an intake of 82.335 grams of chlorine per day, Cow 2 excreted 3.229 grams more of chlorine than she received. These negative chlorine balances cannot signify insufficiency, since the balances were always negative during heaviest consumption of chlorine, and since the three positive balances occurred during the intake of minimum amounts. We seem at all times to have had present in the rations an abundance of chlorine.

Many uncertainties in the interpretation of mineral metabolism data are due to the fact that either positive or negative balances may signify only comparatively unimportant fluctuations in extensive reserves. We do not always have at hand evidence to determine whether a negative balance indicates insufficient intake or merely the throwing off of useless stores in the face of excessive supplies—all of which is equivalent to saying that our balance periods, even the longest of them, are much too short for the most satisfactory study of mineral metabolism.

The potassium balances were positive in all cases but one. The retention varied greatly, in one case (Cow 2, Period II) being 26.837 grams per day. This maximum potassium retention was associated with maximum potassium intake, very largely as contributed by the alfalfa hay in the ration. Apparently enough potassium was present in the rations at all times. The data do not afford us evidence as to just how much potassium is required.

Among the most significant results from this investigation are the balance data relating to calcium, magnesium and phosphorus. As in the previous year's work, all calcium balances were negative, and all magnesium balances but one were negative. In Period I the phosphorus balances were all negative, but in Period II the increased phosphorus intake resulted in all positive balances. With regard to this most important group of mineral nutrients, then, the results are satisfactorily regular and accountable.

In interpreting the uniformly negative calcium balances we might consider them as due possibly (1) to insufficient intake, (2) to the retention being limited by deficiency in the available amounts of the magnesium and phosphorus with which calcium would be combined in storage in the skeleton, and without which calcium cannot be stored in any considerable quantity in any organ or tissue, or (3) to some factor which limits absorption of calcium.

The limited response of the cow to great increase in calcium intake shows that it was not a deficiency of calcium in the ration which caused the negative calcium balances; further, on account of the very high intake of magnesium, it is impossible to consider that this element limited the retention of calcium; and since, in Period II, all phosphorus balances were positive, while the calcium balances remained negative, it is impossible that deficiency of this element should account for the negative calcium balances. The inference, therefore, becomes unmistakable that the cause of the negative calcium balances is some factor which limits calcium absorption, the probability being that the deficient utilization of magnesium and phosphorus is due to the same agency.

We are then confronted with the question, What is this agency and why are these elements so imperfectly absorbed?

In seeking for that condition essential to the appropriation of these nutrients, which limits their utilization by its inadequacy, we have considered the acidity of the gastric juice. If an insufficient supply of hydrochloric acid in the gastric juice restricts the digestion of calcium, magnesium and phosphorus, the administration of these nutrients in water-soluble form, or other forms not requiring the agency of hydrochloric acid to bring them into solution, would shed light on this question. This point will be studied in a later experiment.

Whatever the facts regarding this matter, the formation of the hydrochloric acid of the gastric juice seems not to have been maintained below normal by the sodium chloride intake in the majority of these rations, since doubling the allowance of common salt produced no noticeable change in the utilization of those mineral nutrients which require hydrochloric acid for their digestion.

The nitrogen and sulphur balances measure the protein metabolism. In our earlier study the signs of the nitrogen and sulphur balances (+ or —) were the same in 16 cases out of 18, and in this later investigation they were the same in 9 cases out of 12. The extent of the gains and losses of these elements show that, in general, the cows were maintained in a condition not far from equilibrium, which, for our purpose, signifies that the cows were neither stuffed nor starved; that is, our data and conclusions have to do with cows in a normal state of nutrition.

Table X, pages 472 and 473, contains the amounts of feeds consumed and of milk produced, in pounds; also (in grams) the daily intake and balance of the mineral nutrients and of nitrogen. This table is presented simply as a convenient summary.

Table XI, page 474, records the mineral constituents of the rations expressed as cubic centimeters of the elements. The column at the right shows that the bases exceeded the acids by considerable amounts in all cases, even with the total silicon included. A part of this silicon must have been present as a contamination of soil, and would not enter into metabolic processes. Such variations in balance of base and acid as exist in these rations appear not to affect the retention of the mineral elements.

Table XII records data on the utilization and elimination of nitrogen. The amount of ammonia nitrogen in the urine is very small (0.23-0.76 gm. daily); the elimination of acids in combination with ammonia in the urine (as in omnivora and carnivora) is therefore inconsiderable in extent in cows on such rations as were used in this experiment. Even in the previous study, where (in rations containing timothy hay) the acids exceeded the bases, the urinary ammonia, though slightly increased, remained a very small proportion of the total urinary nitrogen.

The three columns at the right of the table represent the percentage distribution of nitrogen among urine, feces and utilization, the utilized nitrogen being the nitrogen of the milk plus positive (or minus negative) nitrogen balances.

These figures show a marked difference in the proportion of the food nitrogen which is eliminated in the urine, as affected by the kind of hay consumed, there being (on an average) about 27 percent of the nitrogen from the alfalfa rations, and 19 percent of the nitrogen from the clover rations, eliminated in the urine. The proportions of nitrogen in the feces from the alfalfa and the clover hay rations show that the greater proportion of the nitrogen of the alfalfa rations which was excreted in the urine depended upon more complete absorption from the intestine; but the percentage of utilization of nitrogen in the two groups of rations was about the same. It would seem, therefore, that the greater digestibility of the nitrogen compounds of alfalfa does not signify corresponding nutritive superiority.

Table XIII, page 476, sets forth the digestion coefficients of the rations. The only noteworthy differences in digestibility were those just mentioned as due to the effects of the two kinds of hay consumed. In this connection we would call attention to the nutritive ratios of the several rations (column at right of table). We have not data at hand to warrant an opinion as to how much the differences in nutritive ratio of the rations affected the digestibility of the protein. It is a fact not without bearing on this matter, however, that the protein of alfalfa hay is reported in the literature as being more digestible than the protein of clover hay.

In the computation of the protein digestion coefficients correction was made for metabolic nitrogen, which was estimated by the pepsin-hydrochloric acid method.

In accounting for the products from the metabolism of the food, by analysis of milk and excreta, it becomes apparent that there is much variability in the paths of outgo of the mineral nutrients; that is, a given element may be eliminated largely or wholly in the urine, under some circumstances, or, under other conditions, it may be excreted as largely in the feces.

From the point of view of the student of metabolism this great variability in the paths of elimination of the body wastes signifies that it is never safe to draw conclusions from the analysis of urine or feces alone. Both paths of outgo must be considered.

This variability in methods of elimination of wastes also calls our attention to the fact, which is overlooked with discouraging frequency, that we cannot assume that because a nutrient compound appears in the feces, it has escaped absorption. We cannot determine digestion coefficients for ash or for ash constituents, because we cannot distinguish between undissolved constituents and those which have been digested, and after participation in body metabolism, have been reexcreted into the intestine.

A further observation which should be made, relative to the significance of urine and feces analyses, is that the various circumstances which determine the path of outgo of absorbed nutrients are commonly without correspondingly important bearing on the retention of these elements by the body.

In the publication of the results of our first study of the mineral metabolism of the milch cow, we made no attempt to account for the observed variations in the paths of outgo of the mineral nutrients. With the additional evidence derived from the second experiment at hand it now becomes possible more satisfactorily to attempt such deductions. We are recording data on this matter from our second experiment, therefore, in Table XIV, pages 477 and 478, and from the earlier work in Tables XV, XVI and XVII on pages 479 to 481.

A prominent variation is to be noted in the proportionate elimination of sodium and chlorine in the urine and feces. In some cases nearly all the sodium of the excreta was in the urine, while in others it was nearly all in the feces. The same may be said of chlorine. The variations in elimination of sodium and of chlorine in urine and feces are usually roughly parallel, and may be considered as due largely to the amount taken in the food and to varying thoroughness of absorption, as influenced by the length of time the food remains in the digestive tract. High intake of sodium and chlorine increases the outgo of these elements in both urine and feces, but increases the outgo in the urine more than in the feces, thus decreasing the proportionate outgo in the feces. Among those circumstances which tend to increase the proportionate elimination of sodium and of chlorine in the urine are high intake of these elements, constipation, and, as observed in our work with swine,[1] high water intake.

As also observed, first in our work with swine, though sodium and chlorine are usually consumed largely together as sodium chloride, still there is a considerable measure of independence in the metabolism of these elements, because they function to a large extent in different combinations and in different physiological processes.

The path of elimination of potassium is most largely controlled by other influences than those affecting sodium and chlorine. Among the 30 balances involved in this consideration there was a much larger proportionate excretion of potassium in the urine than in the feces in 27 cases. In the other three cases, where the elimination in the feces exceeded that in the urine, the ration fed differed from those in the 27 cases by being rich in silicon and poor in calcium, through the use of timothy instead of clover or alfalfa hay, these differences resulting in a prominent excess of acid to basic minerals in the ration.

Calcium was always very low in the urine, but was slightly higher in the three cases where timothy hay was fed and where an excess of mineral acid to base prevailed.

Magnesium was always contained in much greater quantity in the urine than was calcium. The urine usually contained about one-fourth as much magnesium as did the feces.

The excretion of phosphorus was much like that of calcium. Extremely little was usually present in the urine, though the amount

[1] Ohio Agr. Exp. Sta. Bul 271, A Chemical Study of the Nutrition of Swine (1914).

was slightly increased by the mineral acidity of the ration containing timothy hay. Unlike calcium, however, the urinary phosphorus was sometimes much increased (as in the case of Cow 4, Tables XV, XVI and XVII) by general physiologic disturbance.

Sulphur was usually excreted in the urine in quantities from one-third to one-fourth as great as in the feces. Certain feeds, however, through their high sulphur content, had the effect to increase this proportion in the urine in prominent ways; thus in the work of 1915 (Table XVII, page 481) gluten feed had the effect to increase the proportion of urinary to feces sulphur to more than one-half; and the work of 1916 (Table XIV, pages 477 and 478) showed that alfalfa hay has a marked tendency to increase urinary sulphur. This is especially noticeable with Cow 2, which consumed more alfalfa hay than did other cows. This individual excreted as much sulphur in the urine as in the feces. These variations seem to be consistently related to the intake of sulphur.

SUMMARY

The prevailing belief that all animals which receive leafy forage as a considerable part of the ration consume and digest an abundance of mineral nutriment is shown not to be true, in relation to cows, during ordinarily liberal milk production.

With rations of common practical foods, especially chosen to provide maximum supplies of the mineral nutrients, all calcium, magnesium and phosphorus balances were negative, as in the previous year's work.

With large increases in the calcium, magnesium and phosphorus contents of these rations, through increased amounts of food consumed and through the addition to the rations of large amounts of calcium carbonate and bone flour, all calcium balances and all but one magnesium balance remained negative, but the phosphorus balances became positive.

This work presents satisfactory evidence that in the selective improvement of milch cows we encounter limited capacities to digest calcium, magnesium and phosphorus, and inability to maintain their body stores of these elements before any such limitations are apparent in their ability to digest and to utilize the organic nutrients.

We suggest a restricted capacity for the formation of hydrochloric acid as possibly one of the limiting factors in the utilization of the calcium, magnesium and phosphorus of common foods and of mineral supplements.

Doubling the usual sodium chloride allowance did not improve the retention of calcium, magnesium and phosphorus.

Twenty-eight grams (one ounce) of salt per head and day, with a ration of common foods, provides enough sodium for cows producing 45 pounds of milk per day. An allowance of one to two ounces of salt per head and day, in accord with the amount of milk produced, will cover all sodium requirements.

Rations containing enough sodium to meet the cow's needs commonly contain a larger proportionate supply of chlorine.

Enough potassium seems to have been supplied by all the rations studied. A deficiency of potassium in normal rations, therefore, seems unlikely.

The various circumstances which determine the path of outgo of absorbed nutrients are commonly without corresponding effect on the retention of these elements in the body.

In some cases nearly all the sodium of the excreta was in the urine, while in others it was nearly all in the feces. The same may be said of chlorine.

The elimination of sodium and chlorine in the urine is increased by high intake of these elements, by constipation and by high water intake.

Potassium in cows is commonly excreted in much larger proportion in the urine than in the feces, but in rations characterized by predominance of acid minerals, potassium was eliminated more largely in the feces.

Calcium is excreted by cows almost wholly in the feces, but a predominance of acid minerals in the ration may cause slight increase in urinary calcium.

Magnesium always exceeds calcium in the urine, but is contained in the feces in amounts usually about four times as great as in the urine.

The excretion of phosphorus is characterized by much the same proportionate distribution as the excretion of calcium, except that urinary phosphorus may be much increased by general physiologic disturbance.

Sulphur is normally excreted in the feces, in quantities three or four times as great as in the urine, but with high sulphur intake the urinary sulphur may equal the feces sulphur.

There were no noticeable effects of the foodstuffs or the mineral supplements (sodium chloride, calcium carbonate or bone flour) on the amount or composition of the milk.

Such variations in the balance of acid and basic mineral elements as occur in normal cow rations do not affect the retention of the mineral elements in unmistakable ways.

Evidence was obtained showing that negative balances of the mineral nutrients may signify either deficient intake of the same, or the throwing off of previously absorbed stores, in the face of continued superabundant supplies. Either positive or negative balances may signify, under certain circumstances, only comparatively unimportant fluctuations in extensive reserves.

The nitrogen compounds of rations containing alfalfa hay are more digestible than the nitrogen compounds of rations containing clover hay; they are more completely absorbed from the intestine, but are more largely eliminated in the urine. The greater digestibility of the alfalfa nitrogen, therefore, seems not to signify corresponding nutritive superiority. The percentages of utilization of the nitrogen compounds of rations containing clover and of those containing alfalfa were the same.

The deficient utilization of the minerals by cows, as we have demonstrated the facts, has practical bearings in the malnutrition of the bones of cattle, which is not uncommon after seasons of drouth, and overstocking of pastures, particularly in regions of unfertile, sandy, soils or soils of granitic origin, especially if these be worn through long cropping with deficient fertilization; further practical bearings are probably seen in the rather common failure of cows to breed after a season of forced milk production; also in the failure of many cows fed for high production to maintain high records during consecutive periods of lactation; perhaps also as a contributory cause in the usual shrinkage of milk flow, with advance in the period of lactation.

The most important single result from these studies is that, thus far, under no circumstances, have we been able to cause calcium storage or to maintain calcium equilibrium. That the cow does maintain calcium equilibrium during less abundant milk production may be considered an unproved certainty, though we do not know how much less abundant the production must be in order that the cow may be able to maintain calcium equilibrium.

Among the important factors of this problem which are yet to be investigated are the following:

(1) At what time, and under what conditions of feeding, lactation or reproductive activity does a cow make good the mineral losses sustained during heavy milk production?

(2) Can these losses be prevented, and if so in what manner?

(3) What advantages would accrue to the cow from removing the necessity of her drawing upon her skeleton for a part of the mineral requirements of milk production?

TABLE I.—AVERAGE DAILY FOODS CONSUMED AND MILK PRODUCED; AND LIVE WEIGHTS OF COWS (Kilograms)

Cow No., and days in period		Foods consumed										Milk produced	Weight of cows	
		Corn	Cotton-seed meal	Wheat bran	Linseed oilmeal	Clover hay	Alfalfa hay	Corn silage	Salt	Bone flour	Calcium carbonate		Average first five daily weights	Average last five daily weights
PERIOD I														
2	8	3.5190	0.4692	0.4692	0.2346	....	5.456	13.636	0.0280	....	....	23.622	480.48	475.00
3	14	3.7017	.4936	.4936	.2468	....	3.180	11.940	.0280	....	....	23.640	404.58	400.30
4	14	4.0920	.5456	.5456	.2728	....	3.636	11.360	.0280	....	....	20.528	432.40	440.04
1	20	4.0920	.5456	.5456	.2728	4.544	....	13.636	.0284	....	....	17.560	530.24	533.02
5	20	4.0920	.5456	.5456	.2728	4.544	....	13.636	.0280	....	....	18.779	458.28	451.18
6	20	4.0920	.5456	.5456	.2728	4.544	....	13.636	.0280	....	....	20.012	508.08	508.24
PERIOD II														
2	20	4.0920	.5456	.5456	.2728	....	7.272	15.908	.0560	....	....	26.468	484.12	486.98
3	20	4.4320	.5904	.5904	.2952	....	3.636	13.636	.0560	....	....	23.117	398.80	392.04
4	20	4.0920	.5456	.5456	.2728	....	4.544	12.728	.0560	0.070	....	21.875	447.52	446.36
1	20	4.0920	.5456	.5456	.2728	4.544	....	14.544	.0280	.070	....	20.224	529.20	511.30
5	20	4.7720	.6368	.6368	.3184	4.544	....	15.452	.0280	....	0.070	20.413	460.62	462.08
6	20	4.0920	.5456	.5456	.2728	4.544	....	14.544	.0280	....	.070	20.441	513.24	516.64

TABLE II.—COMPOSITION OF FOODS (Percent)

Food	Dry matter	Ether extract	Crude fiber	Nitrogen	Protein	Nitrogen-free extract	Ash	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus	Silicon
PERIOD I															
Corn	86.55	3.8787	2.420	1.3590	8.4938	70.4025	1.3550	None	0.3514	0.0137	0.1143	0.1227	0.0170	0.2794	0.0130
Cottonseed meal	92.31	6.6733	12.087	5.5314	34.5713	32 9964	5.9820	0.0638	1.4805	0.2031	0.5836	0.3920	0.0151	1.0921	0.0052
Linseed meal	91.86	6.7920	7.563	5.5304	34.5650	36.4560	6.4840	0.0939	1.1801	0.3841	0.5334	0.3757	0.0145	0.7847	0.3492
Wheat bran	89.47	4.1625	8.440	2.7680	17.3000	53.6065	5.9610	0.0790	1.2610	0.1006	0.5161	0.2043	0.0265	1.0198	0.0296
Corn silage (Cows 1, 2, 5 and 6)	28.80	0.8749	6.770	0.3571	2.2319	17.5568	1.3664	None	0.2572	0.0634	0.0496	0.0336	0.0250	0.0520	0.2100
Corn silage (Cows 3 and 4)	28.59	0.9439	6.526	0.3789	2.3681	17.3612	1.3908	0.0023	0.2620	0.0629	0.0533	0.0351	0.0263	0.0544	0.2435
Clover hay	88.16	2.3413	30.409	1.6525	10.3280	38.3435	6.7382	0.0141	1.7393	1.0351	0.2802	0.1153	0.0590	0.1218	0.1933
Alfalfa (Cow 2)	90.61	2.2783	28.490	2.4207	15.1296	35.6920	9.0201	0.2533	2.3023	1.3345	0.2324	0.3306	0.5645	0.1690	0.1690
Alfalfa (Cows 3 and 4)	89.32	2.2457	28.083	2.3861	14.9130	35.1873	8.8910	0.2496	2.2693	1.3153	0.2291	0.3258	0.5564	0.1666	0.1367
PERIOD II															
Corn	87.13	3.8400	2.207	1.4160	8.8500	70.9150	1.3180	None	0.3571	0.0111	0.1181	0.1236	0.0205	0.2721	0.0094
Cottonseed meal	92.81	7.8160	10.377	6.1440	38.4000	30.1100	6.1070	0.0673	1.4894	0.2112	0.5999	0.4270	0.0110	1.1318	0.0028
Linseed meal	92.02	6.8960	7.697	5.4300	33.9375	37.0575	6.4320	0.0829	1.1773	0.3953	0.5385	0.3868	0.0129	0.7837	0.3942
Wheat bran	90.33	4.2080	8.765	2.6715	16.6969	54.7141	5.9460	0.0842	1.2417	0.1107	0.5391	0.2211	0.0221	1.3354	0.0324
Corn silage	27.37	0.7678	6.373	0.3650	2.2813	16.2671	1.6808	None	0.3369	0.0625	0.0610	0.0394	0.0317	0.0617	0.3124
Clover hay	93.62	2.4864	32.294	1.7549	10.9681	40.7157	7.1558	0.0150	1.8471	1.0992	0.2975	0.1225	0.0626	0.1294	0.2053
Alfalfa	91.76	2.1495	30.904	2.1940	13.7125	36.0455	8.9485	0.2039	2.6208	1.2572	0.2344	0.3063	0.5850	0.1804	0.0875
Calcium carbonate	99.87	....	....	....	....	....	97.4500	....	0.1544	32.0740	0.2283	0.0808	0.0035	0.0000	....
Bone flour	97.50	2.6360	....	1.1638	7.2738	....	83.0400	....	0.2220	29.5294	0.6275	0.4548	0.1362	13.4225	....

Composition of salt: Na=39.028; Cl=60.172.

TABLE III.—COMPOSITION OF MILK (Percent)

Cow No.	Moisture	Nitrogen	Protein (N x 6.37)	Ether extract	Ash	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus
PERIOD I												
2	89.21	0.4145	2.6404	2.872	0.741	0.0411	0.1882	0.0991	0.0107	0.0271	0.1209	0.0816
3	88.12	.3627	2.3104	3.994	.697	.0353	.1689	.0971	.0128	.0265	.0922	.0813
4	88.56	.3523	2.2442	2.907	.670	.0311	.1576	.1037	.0105	.0245	.0842	.0726
1	88.14	.4942	3.1481	2.853	.757	.0398	.1657	.1282	.0113	.0309	0806	.0866
5	89.27	.3630	2.3123	2.766	668	.0298	.1689	.1012	.0091	.0211	.0830	.0798
6	88.10	.4347	2.7690	3.229	.730	.0298	.1657	.1241	.0109	.0269	.0732	.0787
PERIOD II												
2	89.80	.3848	2 4512	3.028	.708	.0392	.1906	.0804	.0106	.0251	.1193	.0691
3	88.84	.3884	2.4741	3.269	.665	.0356	.1727	.0840	.0122	.0248	.0981	.0642
4	88 80	.3945	2.5130	2.880	.661	.0298	.1599	.1014	.0097	.0249	.0820	.0718
1	88.87	.4077	2.5970	3.270	.669	.0434	.1559	.0942	.0109	.0260	.0924	.0781
5	89.20	.4063	2.5881	2.686	.716	.0298	.1708	.1081	.0096	.0232	.0792	.0899
6	88.58	.4177	2 6607	3.143	.723	.0330	.1657	.1129	.0100	.0250	.0735	.0825

TABLE IV.—CONSTITUENTS OF DAILY RATIONS (Grams)

Cow No.	Dry matter	Ether extract	Crude fiber	Nitrogen	Protein	Nitrogen-free extract	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus	Silicon
PERIOD I														
2	12984.961	446.871	2676.786	280.504	1753.180	7310.732	25.638	188.684	84.263	29.876	30.617	51.883	37.894	39.296
3	10581.819	397.941	1881.810	226.040	1412.742	6315.417	20.077	132.899	52.292	24.624	22.963	38.553	34.498	34.936
4	11279.510	425.247	1994.106	245.780	1536.122	6704.469	21.299	144.831	58.235	26 517	25.133	41.030	37.334	34.306
1	12717.169	462.056	2536.596	239.762	1498.515	7589.201	12.740	146.662	58.946	31.627	19.121	24.112	37.722	39.094
5	12717.169	462.056	2536.596	239.762	1498.515	7589.201	12.604	146.662	58.946	31.627	19.121	23.901	37.722	39.094
6	12717.169	462.056	2536.596	239.762	1498 515	7589.201	12.604	146.662	58.946	31.627	19.121	23.901	37.722	39.094
PERIOD II														
2	15842.409	520.002	3476.902	338.466	2115.414	8674.734	37.736	276.905	104.655	39.266	38.191	82.335	49.667	57.712
3	12283.070	444.389	2226.242	260.378	1627.373	7281.944	30.409	176.658	57.795	30.390	26.956	60.432	43.910	47.570
4	12537.080	438.792	2431.179	267.821	1673.884	7174.119	32.173	194.851	68.370	30.931	28.900	65.463	52.179	45.390
1	13050.388	466.199	2610.074	253.683	1585.514	7681.743	12.662	165.657	62.326	34.906	20.945	25.358	41.587	56.416
5	14170.285	513.393	2703.917	277.141	1732.132	8405.927	12.839	174.279	85.897	37.708	22.968	25.823	46.605	59.529
6	13120.297	466.199	2610.074	253.683	1585.514	7681.743	12.662	165.765	84.778	35.066	21.002	25.360	41.587	56.416

TABLE V.—CONSTITUENTS OF AVERAGE DAILY MILK (Grams)

Cow No.	Nitrogen	Ether extract	Ash	Sodium	Potassium	Calcium	Magnesium	Sulphur	Phosphorus	Chlorine
PERIOD I										
2	97.9111	678.4095	175.0353	9.7084	44.4557	23.4089	2.5275	6.4014	19.2752	28.5584
3	85.9757	946.7520	165.2194	8.3676	40.0367	23.0169	3.0342	6.2817	19.2716	21.8554
4	72.3159	596.7137	137.5295	6.3838	32.3502	21.2863	2.1553	5.0291	14.9025	17.2836
1	87.0294	502.4176	133.3088	7.0088	29.1800	22.5762	1.9899	5.2870	14.8174	14.1938
5	68.1683	519.4313	125.4447	5.5962	31.7180	19.0045	1.7089	3.9624	14.9858	15.5867
6	86.9885	646.1600	146.0814	5.9633	33.1585	21.8338	2.1812	5.3830	15.7488	14.6482
PERIOD II										
2	102.3889	805.7008	188.3871	10.4305	50.7155	21.3931	2.8205	6.6787	18.3864	31.7438
3	89.7882	755.7094	153.7310	8.2298	39.9238	19.4187	2.8203	5.7331	14.8414	22.6782
4	86.2766	629.8517	144.5597	6.5172	34.9699	22.1760	2.1214	5.4456	15.7026	17.9333
1	82.4508	661.3052	135.2945	8.7770	31.5283	19.0504	2.2044	5.2581	15.7945	18.6864
5	83.1674	549.8094	146.5613	6.0999	34.9618	22.1275	1.9651	4.7489	18.4020	16.2118
6	85.3814	642.4559	147.7873	6.7455	33.8705	23.0777	2.0441	5.1102	16.8637	15.0240

TABLE VI.—CONSTITUENTS OF AVERAGE DAILY URINE (Grams)

Cow No.	Nitrogen	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus
PERIOD I								
2	81.0495	6.3938	114.1110	0.8743	4 7105	12.4388	18.5163	0.1302
3	49.6328	4.8237	67.4443	0.3851	3.7044	6.4814	10.8514	.1147
4	66.1871	0.2753	87.6052	0.5784	6.6311	8.7837	12.0062	.1763
1	49.0082	0.6673	61.3712	2.5431	7.8062	3.15[illegible]2	3 4299	.1228
5	45.4809	0.4200	75.0580	0.0884	3.6996	2.9376	0.2015	.1205
6	38.0211	0 6022	68.7589	0.4[illegible]36	4.2148	2.4160	0.1920	.1040
PERIOD II								
2	103.8532	18.9274	165.0598	0.3881	4.9387	15.5892	36.1458	.1262
3	61.4052	10.0257	97.0465	0.2683	5.6697	8.9556	28.5460	.1185
4	76.8859	10.9434	117.3832	0.4834	7.5302	10.9031	26.9248	.1504
1	54.3890	1.0189	86.7638	0.1738	7.4494	3.6990	0.4812	.1644
5	48.9173	4.5754	98.1876	0.0706	5.0251	3.3989	0.2562	.1163
6	43.3547	1.0834	104.3216	0.3346	4.5982	3.1447	0 2823	.1035

TABLE VII.—CONSTITUENTS OF AVERAGE DAILY FECES (Grams)

Cow No.	Total weight	Dry matter	Ether extract	Crude fiber	Nitrogen	Protein	Metabolic nitrogen	Indigestible nitrogen	Nitrogen-free extract	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus
PERIOD I																
2	30,447	4204.7825	158.6613	1369.7361	110.3413	689.6328	52.7348	57.6064	1595.5036	0.3958	24.6319	67.9585	25.3931	12.3616	12.1790	22.2875
3	23,914	3694.7461	118.8536	982.0133	92.1415	575.8839	47.0153	45.1261	1732.9378	2.6306	18.3900	40.1520	19.9205	9.7331	8.3461	19.8727
4	23,880	3617.8092	126.5397	937.7887	100.2718	626.7009	53.2045	47.0673	1608.9380	8.2625	28.3455	41.8854	19.6771	10.4594	14.3996	23.8561
1	30,124	4473.3472	123.0547	1285.1610	112.0897	700.5594	51.2100	60.8797	1994.9561	1.9580	53.7705	41.1789	24.9423	10.8144	8.2237	26.8100
5	31,080	4658 8545	146.4789	1362.8781	119.7503	748.4406	52.0586	67.6917	2021.5732	7.0551	35.6485	46.5885	29 3393	10.8468	7.2105	24.9260
6	31,353	4709.2657	128.4545	1308.6867	120.3967	752.4781	53.9590	66.4376	2156.5751	2.3201	36.9028	41.2609	27.5595	10.4720	7.1172	24.0793
PERIOD II																
2	40,631	5407.9196	186.2908	1595.4378	140.4190	877.6188	57.8578	82.5612	2222.0008	9.8732	34.2921	88.1276	33.1139	16.0897	17.6743	25.7597
3	29,342	4342.6604	131.1894	1131.1163	109.3001	683 1250	46.3022	62.9979	2038.6667	11.4142	25.2050	44.7470	24.0607	12.1771	10.9740	26.0560
4	27,596	3984.8335	136.2405	1226.9921	102 8495	642.8094	42.8011	60.0485	1555.1961	15.8124	25.2226	68.3548	23.0425	11.7282	21.2488	33.9704
1	32,264	4707.2811	110.2130	1346.2695	116.8593	730.3719	36.5548	80.3045	2039.0516	8.2595	42.3300	66.4633	27.8759	11.9053	8.8725	31.9734
5	36 327	5216.4926	150.9005	1403.5126	132.0833	825.5219	58.5947	73.4886	2367.9451	4.7225	30.0421	70.1829	32.2217	12.2784	7.8465	24.0845
6	33 880	4797.4222	104.6218	1293.7794	113.3967	708.7281	44.8573	68.5394	1755.2724	2.7443	20.7007	68.5733	28.1544	11.2821	10.3334	23.9194

TABLE VIII.—PERIOD I: AVERAGE DAILY RATIONS, AND BALANCES OF MINERALS AND NITROGEN (Grams)

Cow No.	Ave. daily milk yield	Average daily ration	Distinguishing features of rations	Sodium Food Milk Urine Feces Balance	Potassium Food Milk Urine Feces Balance	Calcium Food Milk Urine Feces Balance	Magnesium Food Milk Urine Feces Balance	Sulphur Food Milk Urine Feces Balance	Chlorine Food Milk Urine Feces Balance	Phosphorus Food Milk Urine Feces Balance	Nitrogen Food Milk Urine Feces Balance
2	23,622	Corn, 3519; cottonseed meal, 469.2; wheat bran, 469.2; linseed meal, 234.6; corn silage, 13636; alfalfa hay, 5456; salt, 28	Alfalfa hay	25.638 9.708 6.394 0.396 + 9.140	188.684 44.456 114.111 24.632 + 5.485	84.263 23.409 0.874 67.959 — 7.979	29.876 2.528 4.711 25.393 — 2.756	30.617 6.401 12.439 12.362 — 0.585	51.883 28.558 18.516 12.179 — 7.370	37.894 19.275 0.130 22.288 — 3.799	280.504 97.911 81.050 110.341 — 8.798
3	23,640	Corn, 3701.7; cottonseed meal, 493.6; wheat bran, 493.6; linseed meal, 246.8; corn silage, 11940; alfalfa hay, 3180; salt, 28	"	20.077 8.368 4.824 2.631 + 4.254	132.899 40.037 67.444 18.390 + 7.028	52.292 23.017 0.385 40 152 —11.262	24.624 3.034 3.704 19.921 — 2.035	22.963 6.282 6.481 9.733 + 0.467	38.553 21.855 10.851 8.346 — 2.499	34.498 19.272 0.115 19.873 — 4.762	226.040 85.976 49.633 92.142 — 1.711
4	20,528	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 11360; alfalfa hay, 3636; salt, 28	"	21.299 6.384 0.275 8.263 + 6.377	144.831 32.350 87.605 28.346 — 3.470	58.235 21.286 0.578 41.885 — 5.514	26.517 2.155 6.631 19.677 — 1.946	25 133 5.029 8.784 10.459 + 0.861	41.030 17.284 12.006 14.400 — 2.660	37.334 14.903 0.176 23.856 — 1.601	245.780 72.316 66.187 100.272 + 7.005
1	17,560	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 13636; clover hay 4544; salt, 28.35	Clover hay	12.740 7.009 0.667 1.958 + 3.106	146.662 29.180 61.371 53.771 + 2.340	58.946 22.576 2.543 41.179 — 7.352	31.627 1.990 7.806 24.942 — 3.111	19.121 5.287 3.154 10.814 — 0.134	24.112 14.194 3.430 8.224 — 1.736	37.722 14.817 0.123 26.810 — 4.028	239.762 87.029 49.008 112.090 — 8.365
5	18,779	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 13636; clover hay, 4544; salt, 28	"	12.604 5.596 0.420 7.055 — 0.467	146.662 31.718 75.058 35.649 + 4.237	58.946 19.005 0.088 46.589 — 6.736	31.627 1.709 3.700 29.339 — 3.121	19.121 3.962 2.938 10.847 + 1.374	23.901 15.587 0.202 7.211 + 0.901	37.722 14.986 0.121 24.926 — 2.311	239.762 68.168 45.487 119.750 + 6.357
6	20,012	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 13636; clover hay, 4544; salt, 28	"	12.604 5.963 0.662 2.320 + 3.659	146.662 33.159 68.759 36.903 + 7.841	58.946 24.834 0.414 41.261 — 7.563	31.627 2.181 4.215 27.560 — 2.329	19.121 5.383 2.416 10.472 + 0.850	23.901 14.648 0.192 7.117 + 1.944	37.722 15.749 0.104 24.079 — 2.210	239.762 86.989 38.021 120.397 — 5.645

TABLE IX.—PERIOD II: AVERAGE DAILY RATIONS, AND BALANCES OF MINERALS AND NITROGEN (Grams)

Cow No.	Ave. daily milk yield	Average daily ration	Distinguishing features of rations		Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus	Nitrogen
					Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance	Food Milk Urine Feces Balance
2	26,468	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 15908; alfalfa hay, 7272; salt, 56	Alfalfa hay	Salt, 56 grams	37.736 10.431 18.927 9.873 − 1.495	276.905 50.716 165 060 34.292 + 26.837	104.655 21.393 0.388 88.128 − 5.254	39.266 2.821 4.939 33.114 − 1.608	38.191 6.679 15 589 16.090 − 0.167	82.335 31.744 36.146 17.674 − 3.229	49.667 18.386 0.126 25.760 + 5.395	338.466 102.389 103.853 140.419 − 8.195
3	23,117	Corn, 4432; cottonseed meal, 590.4; wheat bran, 590.4; linseed meal, 295.2; corn silage, 13636; alfalfa hay, 3636; salt, 56	Alfalfa hay	"	30.409 8.230 10.026 11.414 + 0.739	176.658 39 924 97.047 25.205 + 14.482	57.795 19.419 0.268 44.747 − 6.639	30.390 2.820 5.670 24.061 − 2.161	26.956 5.733 8.956 12.177 + 0.090	60.432 22.678 28.546 10.974 − 1.766	43.910 14.841 0.119 26 056 + 2.894	260.378 89.788 61.405 109.300 − 0.115
4	21,875	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 12728; alfalfa hay, 4544; salt, 56; bone flour, 70	Alfalfa hay; bone flour	"	32.173 6.517 10.943 15.812 − 1.099	194.851 34.970 117.383 25.223 + 17.275	89.041 22.176 0.483 68.355 − 1.973	31.370 2.121 7.530 23.043 − 1.324	28.900 5.446 10.903 11.728 + 0.823	65.463 17.933 26.925 21.249 − 0.644	52.179 15.703 0.150 33.970 + 2.356	267.821 86.277 76 886 102.850 + 1.808
1	20,224	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 14544; clover hay, 4644; salt, 28; bone flour, 70	Clover hay; bone flour	Salt, 28 grams	12.662 8.777 1.019 8.260 − 5.394	165.812 31.528 86.764 42 330 + 5.190	82.997 19.050 0.174 66.463 − 2.690	35.345 2.204 7.449 27.876 − 2.184	21.263 5.258 3.699 11.905 + 0.401	25.453 18.686 0.481 8.873 − 2.587	50.983 15.795 0.164 31.973 + 3.051	254.498 82.451 54.389 116.859 + 0.799
5	20,413	Corn, 4772; cottonseed meal, 636.8; wheat bran, 636.8; linseed meal, 318.4; corn silage, 15452; clover hay, 4544, salt, 28; calcium carbonate, 70	Clover hay; calcium carbonate	"	12.839 6.100 4.575 4.723 − 2.559	174.279 34.962 98.188 30.042 + 11.087	85.897 22.128 0.071 70.183 − 6.485	37.708 1.965 5.025 32.222 − 1.504	22.968 4.749 3.399 12.278 + 2.542	25.823 16.212 0.256 7.847 + 1.508	46.605 18.402 0.116 24.085 + 4.002	277.141 83.167 48.917 132.083 + 12.974
6	20 441	Corn, 4092; cottonseed meal, 545.6; wheat bran, 545.6; linseed meal, 272.8; corn silage, 14544; clover hay, 4544; salt, 28; calcium carbonate, 70	Clover hay; calcium carbonate	"	12.662 6.746 1.083 2.744 + 2.089	165.765 33.871 104.322 20.701 + 6.871	84.778 23.078 0.335 68.573 − 7.208	35.066 2.044 4.598 28.154 + 0.270	21.002 5.110 3.145 11.282 + 1.465	25.360 15.024 0.283 10.333 − 0.280	41.587 16.864 0.104 23.919 + 0.700	253.683 85.381 43.355 113.397 + 11.550

TABLE X.—AVERAGE DAILY FEED, MILK AND BALANCE DATA FROM SIX COWS—Continued

Cow No.	Rations (Pounds)	Distinguishing features of rations	Milk yield	Gain or loss to the body (Grams)							
				Sodium Intake Balance	Potassium Intake Balance	Calcium Intake Balance	Magnesium Intake Balance	Sulphur Intake Balance	Chlorine Intake Balance	Phosphorus Intake Balance	Nitrogen Intake Balance
PERIOD I			*Lb.*								
2	Corn, 7.758; cottonseed meal, 1.034; wheat bran, 1.034; linseed meal, 0.517; corn silage, 30.062; alfalfa hay, 12.028 salt, 0.062	Alfalfa hay	52.077	25.638 + 9.140	188.684 + 5.485	84.263 — 7.979	29.876 — 2.756	30 617 — 0.585	51.883 — 7.370	37.894 — 3.799	280.504 — 8.798
3	Corn, 8.161; cottonseed meal, 1.088; wheat bran, 1.088; linseed meal, 0.544; corn silage, 26.323; alfalfa hay, 7.011; salt, 0.062	" "	52.116	20.077 + 4.254	132.899 + 7.028	52.292 —11.262	24.624 — 2.035	22.963 + 0.467	38.553 — 2.499	34.498 — 4.762	226.040 — 1.711
4	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 25.044; alfalfa hay, 8.016; salt, 0.062	" "	45.256	21.299 + 6.377	144.831 — 3.470	58.235 — 5.514	26.517 — 1.946	25.133 + 0.861	41.030 — 2.660	37.334 — 1.601	245.780 + 7.005
1	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 30.062; clover hay, 10.018; salt, 0.063	Clover hay	38.713	12 740 + 3.106	146.662 + 2.340	58.946 — 7.352	31.627 — 3.111	19.121 — 0.134	24.112 — 1.736	37.722 — 4.028	239.762 — 8.365
5	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 30.062; clover hay, 10.018; salt, 0.062	" "	41.400	12.604 — 0.467	146.662 + 4.237	58.946 — 6.736	31.627 — 3.121	19.121 + 1.374	23.901 + 0.901	37.722 — 2.311	239.762 + 6.357
6	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 30.062; clover hay, 10.018; salt, 0.062	" "	44.118	12.604 + 3.659	146.662 + 7.841	58.946 — 7.563	31.627 — 2.329	19.121 + 0.850	23.901 + 1.944	37.722 — 2.210	239.762 — 5.645

TABLE X.—AVERAGE DAILY FEED, MILK AND BALANCE DATA FROM SIX COWS—Concluded

Cow No.	Rations (Pounds)	Distinguishing features of rations		Milk yield	Gain or loss to the body (Grams)							
					Sodium Intake Balance	Potassium Intake Balance	Calcium Intake Balance	Magnesium Intake Balance	Sulphur Intake Balance	Chlorine Intake Balance	Phosphorus Intake Balance	Nitrogen Intake Balance
PERIOD II				*Lb.*								
2	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 35.071; alfalfa hay, 16.032; salt, 0.123	Alfalfa hay	Salt, 56 grams	58.351	37.736 − 1.495	276.905 + 26 837	104.655 − 5.254	39.266 − 1.608	38.191 − 0.167	82.335 − 3.229	49.667 + 5.395	338.466 − 8.195
3	Corn, 9.771; cottonseed meal, 1.302; wheat bran, 1.302; linseed meal, 0.651; corn silage, 30.062; alfalfa hay, 8.016; salt, 0.123	Alfalfa hay	"	50.963	30.409 + 0.739	176.658 + 14.482	57.795 − 6.639	30.360 − 2.161	26.956 + 0.090	60.432 − 1.766	43.910 + 2.894	260.378 − 0.115
4	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 28.060; alfalfa hay, 10 018; salt, 0.123; bone flour, 0.154	Alfalfa hay; bone flour	"	48.225	32.173 − 1.099	194.851 + 17.275	89.041 − 1.973	31.370 − 1.324	28.900 + 0.823	65.463 − 0.644	52.179 + 2.356	267.821 + 1.808
1	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0601; corn silage, 32.063; clover hay, 10.018 salt, 0.062; bone flour, 0.154	Clover hay; bone flour	Salt, 28 grams	44.586	12.662 − 5.394	165.812 + 5.190	82.997 − 2.690	35 345 − 2.184	21.263 + 0.401	25.453 − 2.587	50 983 + 3.051	254.498 + 0.799
5	Corn, 10.520; cottonseed meal, 1.404; wheat bran, 1.404; linseed meal, 0.702; corn silage, 34.065; clover hay, 10 018; salt, 0.062; calcium carbonate, 0.154	Clover hay; calcium carbonate	"	45.002	12.839 − 2.559	174.279 + 11.087	85.897 − 6.485	37.708 − 1.504	22.968 + 2.542	25.823 + 1.508	46.605 + 4.002	277.141 + 12.974
6	Corn, 9.021; cottonseed meal, 1.203; wheat bran, 1.203; linseed meal, 0.601; corn silage, 32.063; clover hay, 10.018; salt, 0.062; calcium carbonate, 0.154	Clover hay; calcium carbonate	"	45.064	12.662 + 2.089	165.765 + 6.871	84.778 − 7.208	35.066 + 0 270	21.002 + 1.465	25.360 − 0.280	41.587 + 0.700	253.683 + 11.550

TABLE XI.—MINERALS IN DAILY RATIONS COMPUTED TO NORMAL SOLUTIONS (Cubic Centimeters)

Cow No.	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus	Silicon	Total base	Total acid	Excess base
PERIOD I											
2	1115	4826	4206	2457	1909	1463	2442	2777	12604	8591	4013
3	873	3399	2610	2025	1432	1087	2223	2469	8907	7211	1696
4	926	3704	2907	2181	1567	1157	2406	2424	9718	7554	2164
1	554	3751	2942	2601	1192	680	2431	2763	9848	7066	2782
5	548	3751	2942	2601	1192	674	2431	2763	9842	7060	2782
6	548	3751	2942	2601	1192	674	2431	2763	9842	7060	2782
PERIOD II											
2	1641	7082	5224	3229	2382	2322	3200	4079	17176	11983	5193
3	1322	4518	2885	2499	1681	1704	2829	3362	11224	9576	1648
4	1399	4983	3413	2544	1802	1846	3362	3208	12339	10218	2121
1	551	4237	3111	2871	1306	715	2680	3987	10770	8688	2082
5	558	4457	4287	3101	1432	728	3003	4207	12403	9370	3033
6	551	4240	4231	2884	1310	715	2680	3987	11906	8692	3214

TABLE XII.—UTILIZATION AND ELIMINATION OF NITROGEN

Cow No.	Distinguishing features of rations		Nitrogen of rations per day	Nitrogen in urine per day	Ammonia nitrogen in urine per day	Ammonia nitrogen in urinary nitrogen	Nitrogen of food in urine	Utilization of nitrogen	Nitrogen of food in feces
PERIOD I			*Grams*	*Grams*	*Grams*	*Percent*	*Percent*	*Percent*	*Percent*
2	Alfalfa hay		280.504	81.0495	0.5239	0.65	28.89	31.77	39.34
3	" "		226.040	49.6328	0.7192	1.45	21.96	37.28	40.76
4	" "		245.780	66.1871	0.4481	0.68	26 93	32.27	40.80
1	Clover hay		239.762	49.0082	0.7588	1.55	20.44	32 81	46.75
5	" "		239.762	45.4869	0.2657	0.58	18.97	31.08	49.95
6	" "		239.762	38.0211	0.6509	1.71	15.86	33.93	50 22
PERIOD II									
2	Alfalfa hay	Salt, 56 grams	338 466	103.8532	0.4931	0.48	30.68	27.83	41.49
3	Alfalfa hay	" "	260.378	61.4052	0.6679	1.09	23.58	34 44	41.98
4	Alfalfa hay; bone flour	" "	267.821	76.8859	0.3753	0.49	28.71	32.89	38.40
1	Clover hay; bone flour	Salt, 28 grams	253.683	54.3890	0.2306	0.42	21.44	32.71	45.92
5	Clover hay; calcium carbonate	" "	277.141	48.9173	0 2373	0.49	17.65	34.69	47.66
6	Clover hay; calcium carbonate	" "	253.683	43.3547	0.3491	0.81	17.09	38.21	44.70

TABLE XIII.—COEFFICIENTS OF DIGESTIBILITY OF RATIONS

Cow No.	Distinguishing features of rations		Protein	Nitrogen-free extract	Ether extract	Crude fiber	Nutritive ratio of rations
PERIOD I							
2	Alfalfa hay		79 463	78.18	64.495	48.83	1 . 6.27
3	" "		80.036	72 56	70.133	47.82	1 ; 6.65
4	" "		80.850	76.00	70.243	52.97	1 . 6.47
1	Clover hay		74.608	73.71	73.368	49.34	1 . 8.06
5	" "		71.767	73.36	68.298	46.27	1 . 8 06
6	" "		72.290	71.58	72.199	48.41	1 : 8.06
PERIOD II							
2	Alfalfa hay	Salt, 56 grams	75 607	74.39	64.175	54.11	1 : 6.22
3	Alfalfa hay	" " "	75.805	72 00	70.479	49.19	1 : 6.66
4	Alfalfa hay; bone flour	" " "	77.579	78.32	68.951	49.53	1 : 6.43
1	Clover hay; bone flour	Salt, 28 grams	68.345	73.46	76.359	48.42	1 : 7.74
5	Clover hay; calcium carbonate	" " "	73.483	71.83	70.607	48.09	1 . 7.66
6	Clover hay; calcium carbonate	" " "	72.982	77.15	77 559	50.43	1 : 7.74

TABLE XIV.—PERIOD I, 1916: DISTRIBUTION OF OUTGO OF ELEMENTS AMONG MILK, URINE AND FECES (Percent)

Cow No.	Rations	Distinguishing features of rations	Sodium Milk Urine Feces	Potassium Milk Urine Feces	Calcium Milk Urine Feces	Magnesium Milk Urine Feces	Sulphur Milk Urine Feces	Chlorine Milk Urine Feces	Phosphorus Milk Urine Feces	Nitrogen Milk Urine Feces
2	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt	Alfalfa hay	58.84 38.76 2.40	24.27 62.29 13.44	25.38 0.95 73.67	7.75 14.44 77.81	20.51 39.87 39.62	48.20 31.25 20.55	46.23 0.31 53.46	33.84 28.02 38.14
3	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt	"	52.89 30.49 16.62	31.81 53 58 14.61	36.22 0.61 63.18	11.39 13 89 74.72	27.92 28.81 43.27	53.24 26 43 20.33	49.09 0.29 50.62	37.75 21.79 40.46
4	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt	" "	42.78 1.84 55.38	21.81 59.07 19.12	33.39 0.91 65.70	7.57 23.30 69.13	20.72 36.19 43.09	39.56 27.48 32.96	38.28 0.45 61.27	30.29 27.72 41.99
1	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; clover hay; salt	Clover hay	72.75 6.92 20.33	20.22 42.52 37.26	34.05 3 84 62.11	5.73 22.47 71.80	27.46 16.38 56.16	54 91 13.27 31.82	35.49 0.29 64.22	35.08 19.75 45.17
5	Corn; cottonseed meal; wheat bran; linseed meal; corn silage, clover hay; salt	" "	42.81 3.21 53.98	22.27 52.70 25.03	28.94 0.13 27.93	4.92 0.65 84.43	22.32 16.56 61.12	67.77 0 88 31.35	37.44 0.30 62.26	29.21 19.49 51.30
6	Corn; cottonseed meal; wheat bran; linseed meal; corn silage, clover hay; salt	" "	66.66 7.40 25.94	23.89 49.53 26.58	37.34 0 62 62.04	6.42 12.42 81.16	29.46 13.23 57.31	66.71 0.88 32.41	39.44 0.26 60.30	35.45 15 49 49.06

TABLE XIV.—PERIOD II, 1916: DISTRIBUTION OF OUTGO OF ELEMENTS AMONG MILK, URINE AND FECES (Percent)

Cow No.	Rations	Distinguishing features of rations		Sodium Milk Urine Feces	Potassium Milk Urine Feces	Calcium Milk Urine Feces	Magnesium Milk Urine Feces	Sulphur Milk Urine Feces	Chlorine Milk Urine Feces	Phosphorus Milk Urine Feces	Nitrogen Milk Urine Feces
2	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt	Alfalfa hay	Salt, 56 grams	26.59 48.24 25.17	20.28 66.01 13.71	19.47 0.35 80.18	6.90 12.08 81.02	17.41 40.64 41.95	37.10 42.24 20.66	41.53 0.28 58.19	29.54 29.96 40.50
3	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt	Alfalfa hay	"	27.74 33.79 38.47	24.62 59.84 15.54	30.14 0.41 69.45	8.66 17.42 73.92	21.34 33.34 45.32	36.46 45.90 17.64	36.18 0.29 63.53	34.47 23.57 41.96
4	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; alfalfa hay; salt; bone flour	Alfalfa hay; bone flour	"	19.59 32.89 47.52	19.69 66.10 14.21	24.37 0.53 75.10	6 49 23.03 70.48	19.40 38.83 41.77	27.13 40.73 32.14	31.52 0.30 68.18	32.43 28.90 38.67
1	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; clover hay; salt; bone flour	Clover hay; bone flour	Salt, 28 grams	48.61 5.64 45.75	19.63 54.02 26.35	22.23 0.20 77.57	5.87 19.85 74.28	25.20 17.73 57.07	66.64 1.72 31.64	32.95 0.34 66.71	32.50 21.44 46.06
5	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; clover hay; salt; calcium carbonate	Clover hay; calcium carbonate	"	39.62 29.71 30.67	21.42 60.17 18.41	23.95 0.08 75.97	5.01 12.82 82.17	23.25 16.64 60.11	66.68 1.05 32.27	43.20 0.27 56.53	31.48 18.52 50.00
6	Corn; cottonseed meal; wheat bran; linseed meal; corn silage; clover hay; salt; calcium carbonate	Clover hay; calcium carbonate	"	63.80 10.24 25.95	21.32 65.65 13.03	25.09 0.36 74.55	5.87 13.22 80.91	26.16 16.10 57.74	58.60 1.10 40.30	41.25 0.25 58.50	35.26 17.91 46.83

TABLE XV.—PERIOD I, 1915: DISTRIBUTION OF OUTGO OF ELEMENTS AMONG MILK, URINE AND FECES (Percent)

No.	Rations	Sodium Milk Urine Feces	Potassium Milk Urine Feces	Calcium Milk Urine Feces	Magnesium Milk Urine Feces	Sulphur Milk Urine Feces	Chlorine Milk Urine Feces	Phosphorus Milk Urine Feces	Silicon Milk Urine Feces	Nitrogen Milk Urine Feces
1	Corn; cottonseed meal; timothy hay; corn silage; salt	51.87 8.24 39.89	29.88 13.13 56.99	41.95 2.17 55.88	7.24 25.93 66.83	20.99 13.93 65.08	45.89 27.28 26.83	36.65 2.26 61.09	.... 1.17 98.83	34.02 17.33 48.65
2	Corn; cottonseed meal; timothy hay; corn silage; salt	59.22 25.01 15.77	31.08 17.64 51.28	35.66 2.62 61.72	5.25 20.29 74.46	21.44 21.18 57.38	57.55 15.09 27.36	37.65 5.34 57.01	.... 1.54 98.46	24.55 23.91 51.54
3	Corn; cottonseed meal; timothy hay; corn silage; salt	77.17 10.84 11.99	26.93 16.56 56.51	36.83 5.90 57.27	5.45 14.53 80.02	18.16 19.18 62.66	69.87 5.82 24.31	33.25 0.23 66.52	.... 1.06 98.94	24.18 21.67 54.15
4	Corn; cottonseed meal; clover hay; salt	51.01 42.96 6.03	25.24 59.45 15.31	23.55 .... 76.45	6.27 21.63 72.10	29.99 14.61 55.40	83.61 .... 16.39	43.72 4.23 52.05	.... 3.34 96.66	26.66 21.43 51.91
5	Corn; cottonseed meal; clover hay; salt	42.42 33.99 23.59	24.94 59.15 15.91	20.92 .... 79.08	5.04 23.14 71.82	21.82 18.91 59.27	88.86 .... 11.14	38.18 1.20 60.62	.... 1.63 98.37	18.89 32.86 48.25
6	Corn; cottonseed meal; clover hay; salt	44.48 39.31 16.21	26.61 50.22 23.17	21.91 .... 78.09	6.11 24.34 69.55	22.31 16.94 60.75	81.10 .... 18.90	42.22 0.50 57.28	.... 100.00	23.63 28.14 48.23

TABLE XVI.—PERIOD II, 1915: DISTRIBUTION OF OUTGO OF ELEMENTS AMONG MILK, URINE AND FECES (Perçent)

Cow No.	Rations	Sodium Milk Urine Feces	Potassium Milk Urine Feces	Calcium Milk Urine Feces	Magnesium Milk Urine Feces	Sulphur Milk Urine Feces	Chlorine Milk Urine Feces	Phosphorus Milk Urine Feces	Silicon Milk Urine Feces	Nitrogen Milk Urine Feces
1	Corn; cottonseed meal; clover hay; corn silage; salt	68.35 30.39 1.26	24.74 60.14 15 12	25.87 0.14 73.99	5.69 21 26 73.05	25.24 15.72 59.04	55.09 1.43 43.48	45.11 0.39 54.50	.... 1.62 98.38	33.03 17.28 49.69
2	Corn; cottonseed meal; clover hay; corn silage; salt	43.81 31.79 24.40	23 95 60.99 15.06	22.23 0.20 77.57	4.70 22.23 73.07	23 06 18.40 58.54	62.84 0.84 36.32	47.12 0.72 52.16	.... 1.36 98.64	24.23 28.13 47.64
3	Corn; cottonseed meal; clover hay; corn silage; salt	64.03 33.28 2.69	23.66 63.08 13.26	24.57 0.11 75.32	4.44 19.16 76.40	23.64 18.29 58.07	72.44 0.65 26.91	50.04 0.32 49.64	.... 0.79 99.21	27.10 19.36 53.54
4	Corn; distiller's grains; clover hay; corn silage; salt	75.43 14.13 10.44	23.44 57.94 18.62	25.45 0.12 74.43	6.26 20.07 73.67	20.58 18.53 60.89	77.33 0.55 22.12	49.52 1.79 48.69	.... 1.02 98.98	27.27 24.67 48.06
5	Corn; distiller's grains; clover hay; corn silage; salt	59.87 16.72 23.41	24 90 59.96 15.14	22.81 0.13 77.06	6.33 21 51 72.16	19.85 19.22 60.93	79.60 0.69 19.71	44.57 0.57 54.86	.... 1.20 98.80	24.32 27.13 48.55
6	Corn; distiller's grains; clover hay; corn silage; salt	49.05 32 81 18.14	28.33 53.69 17.98	25.31 0.27 74.42	7.25 22.29 70.46	23.15 18.98 57.87	65.26 6.21 28.53	54.88 0.28 44.84	.... 0.60 99.40	30.11 22.21 47.68

TABLE XVII.—PERIOD III, 1915: DISTRIBUTION OF OUTGO OF ELEMENTS AMONG MILK, URINE AND FECES (Percent)

Cow No.	Rations	Sodium	Potassium	Calcium	Magnesium	Sulphur	Chlorine	Phosphorus	Silicon	Nitrogen
1	Corn; linseed oilmeal; clover hay; corn silage; salt	68.78 11.90 19.32	23.89 58.89 17.22	24.88 0.02 75.10	6.08 21.86 72.06	28.10 16.61 55.29	61.96 2.40 35.64	45.74 0.31 53.95	.... 1.62 98.38	33.73 21.22 45.05
2	Corn; linseed oilmeal; clover hay; corn silage; salt	51.65 13.37 34 98	20.19 64.16 15.65	24.43 0.03 75.54	4.06 19.79 76.15	22.76 19.45 57.79	62.08 0.77 37.15	39.26 0.59 60.15	.... 1.30 98.70	25.91 28.58 45.51
3	Corn; linseed oilmeal; clover hay; corn silage; salt	45.85 14.74 39.41	21.28 66.39 12.33	23.49 0.02 76.49	4.27 20.43 75.30	22.94 19.06 58.00	76.07 0.70 23.23	40.87 0.38 58.75	.... 1.83 98.17	24.28 25.77 49.95
4	Corn; gluten feed; clover hay; corn silage; salt	61.54 21.38 17.08	18.82 59.96 21.22	25.83 0.03 74.14	4.66 20.73 74.61	18.03 29.29 52.68	70.75 0.72 28.53	37.01 11.07 51.92	.... 2.08 97.92	27.22 26.26 46.52
5	Corn; gluten feed; clover hay; corn silage; salt	69.51 3.25 27.24	19.37 57.81 22.82	19.84 0.21 79.95	4.40 20.45 75.15	18.51 28.79 52.70	69.76 0.36 29.88	30.15 0.47 69.38	.... 1.76 98.24	24.79 27.15 48.06
6	Corn; gluten feed; clover hay; corn silage; salt	53.32 26.74 19.94	18.86 51.42 29.72	23.60 0.09 76.31	4.55 21.66 73.79	19.09 29.27 51.64	51.72 3.38 44.90	37.62 0.29 62.09	.... 1.22 98.78	27.92 25.35 46.73