South Dakota State University
Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange

Bulletins

South Dakota State University Agricultural Experiment Station

3-1920

Relative Values of Feed Proteins for Dairy Cows

C. Larsen

T. Wright

H. Jones

H. Hoover

Follow this and additional works at: http://openprairie.sdstate.edu/agexperimentsta_bulletins

Recommended Citation
Larsen, C.; Wright, T.; Jones, H.; and Hoover, H., "Relative Values of Feed Proteins for Dairy Cows" (1920). *Bulletins.* Paper 188.
http://openprairie.sdstate.edu/agexperimentsta_bulletins/188

This Bulletin is brought to you for free and open access by the South Dakota State University Agricultural Experiment Station at Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in Bulletins by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact michael.biondo@sdstate.edu.

Bulletin No. 188 March, 1920

RELATIVE VALUES OF FEED PROTEINS FOR DAIRY COWS

Dairy Husbandry Department

AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE OF
AGRICULTURE AND MECHANIC ARTS

Brookings, South Dakota

GOVERNING BOARD

Hon. T. W. Dwight, President ..... Sioux Falls
Hon. August Frieberg, Vice-President ..... Beresford
Hon. T. A. Potwin ..... Lemmon
Hon. J. W. Campbell ..... Huron
Hon. F. A. Spafford ..... Flandreau

STATION STAFF

T. W. Dwight ..... Regent Member
J. W. Campbell ..... Regent Member
Willis E. Johnson ..... President of College
James W. Wilson ..... Director and Animal Husbandman
N. E. Hansen ..... Vice-Director and Horticulturist
C. Larsen ..... Dairy Husbandman
A. N. Hume ..... Agronomist and Supt. of Sub-Stations
J. G. Hutton ..... Associate Agronomist
Manley Champlin .... Associate Agronomist and Collaborator
Howard Loomis ..... Agronomy Analyst
Matthew Fowlds ..... Assistant Agronomist
T. H. Wright, Jr. ..... Associate Dairy Husbandman
H. M. Jones ..... Assistant Dairy Husbandman
B. L. Johnson ..... Dairy Analyst
H. Hoover ..... Dairy Analyst
A. H. Kuhlman ..... Associate Animal Husbandman
R. A. Larson ..... Secretary
P. W. Hanson ..... Bulletin Clerk and Stenographer

RELATIVE VALUES OF FEED PROTEINS FOR DAIRY COWS

C. Larsen, T. Wright, H. Jones, H. Hoover and B. Johnson.

INTRODUCTION

Will a given amount of the protein of oil meal, for example, be of equal value in supplying the needs of a milk cow as will the same amount of the protein of some other feed? To find a satisfactory answer to the above question, asked by many dairymen, has been the aim of the present investigation as reported in this bulletin.

It has long been known that the protein from different sources varied in its ability to supply the protein demands of an animal. Numerous investigations have dealt with a study of the so-called "pure proteins" which have been found to vary in their relative values. Comparatively few of these investigations have dealt with a study of protein as it occurs and is fed in the ordinary feeds. Even fewer have concerned themselves with this protein problem as regards animals producing milk.

The present investigation deals with the relative value of the protein of common feeds in supplying the protein requirements of cows producing milk.

PLAN OF INVESTIGATION

This investigation is divided into two parts. Series I, carried on in 1917 was interrupted by circumstances due to the war, and the work could not be continued until late in 1918 when Series II was begun. The two series were conducted along similar lines, differing only in minor details. The observations made during Series I indicated that minor changes were advisable in continuing the work.

The two series agree quite closely in the general plan of procedure. The chief points were as follows:

1. It was thought that by feeding a basal ration low in protein constituents, and thereby securing a negative nitrogen balance, some light might be thrown on the protein requirements for nitrogen equilibrium and the amount of protein katabolized or torn down.

2. By supplementing this basal ration with certain feeds containing a high percent of protein and by comparing the effectiveness of these various proteins in diminishing or decreasing the amount of the negative nitrogen balance, it was thought that some definite conclusions might be drawn in regard to the relative values of these proteins in supplying the needs of cows producing milk.

3. It was recognized that in making these comparisons certain factors should be considered, such as, an increase or decrease in body weight and milk production, probable increase of availability of all nutrients with an addition of protein to the ration, and probable changes in the plane of protein nutrition and in the therms net energy required.

The Feeds

No attempt was made to use a large number of feeds. This investigation was confined to a study of the proteins of oil meal and gluten feed. They were ordinary grades of the commercial products sold under these names. A sufficient supply was provided before the beginning of each series of feeding periods to last throughout. This was done to insure uniformity of product and to do away with the possibility of having to suspend the work at any time for lack of feed.

The Cows

The cows used in this investigation were common cows, at least two months along in the lactation period, in fair condition but not fat, and were not in calf. During the entire series of feeding periods they never left their stalls except to be weighed. Three cows were used in Series I and four in Series II. While different cows were used in the two series, they were as nearly alike as possible in all respects.

The Feeding Periods

Series I consisted of six periods and Series II of four. During the first period of each series, the cows were put on a basal ration of prairie hay and silage. In every case this ration gave a negative nitrogen balance, that is, the amount of nitrogen given off in milk, urine and feces was greater than the amount consumed in the basal ration.

Taking into consideration the amount of negative nitrogen balance, during Period I, oil meal and gluten feed were given in amounts which theoretically contained sufficient nitrogen to give a balance. During Periods II, III, and IV of Series I, oil meal was fed in amounts determined from the results of the basal period. To what extent the investigators succeeded in establishing nitrogen equilibrium may be seen by referring to Tables I to XX inclusive covering the intake and outgo of these periods. Gluten feed was fed during Periods V and VI of this first series. The amount required for a balance was calculated from the negative nitrogen balance of Period I.

Series II was conducted slightly different as regards the order in which the feeds were given. It was observed from Series I that as the feeding periods succeeded each other, there were changes in some of the factors (aside from the source of the feed protein) which caused the availability of the protein to vary.

To overcome this difficulty the feeds were alternated, that is, oil meal was fed to two cows and gluten feed to the other two during one period, and these feeds were reversed for the period following. During Period II, Cows 1 and 2 received the basal ration supplemented by oil meal and during Period III gluten feed. Cows 3 and 4 received gluten feed during Period II and oil meal during Period III. All were put on the basal ration for Period IV.

Five days before the beginning of each period the cows were put on the exact ration for that period. This was done to accustom the system of the cow to that particular ration and to establish as nearly as possible the plane of nutrition provided by such a ration. This made each feeding period fifteen days in length although the analyses of outgo covered only the last ten days.

Details of Feeding

Divided mangers offered opportunity to measure carefully the intake of each cow. The hay and silage for each cow were placed in sacks and weighed. The amount left in the sacks

at the end of the day was weighed back and the difference constituted the amount of the respective feeds to which the cow had access. The desired amount of concentrates was weighed in a bucket in the usual manner each day and given in two feeds. All feed refused was collected once a day, placed in a separate sack for each cow and weighed and analyzed at the end of each ten day period. This amount subtracted from the amount which was fed constituted the actual intake of food.

Water was provided regularly and in such quantities as each cow desired, the weight being recorded at each watering. Prairie hay and corn silage made up the basal ration which was fed during the first ten day period of each series. The hay was fed whole in Series I but it was deemed advisable to cut it finely for Series II, as in that way a more representative sample could be obtained for analysis. To the basal ration were added quantities of oil meal or gluten feed sufficient to establish and maintain nitrogen equilibrium as nearly as could be determined. All feeds of each feeding period were analyzed according to methods which will be described later.

Collecting and Sampling Outgo

The cows were milked twice a day into weighed buckets and careful record was kept of the amount of milk produced throughout both series. For purposes of analysis composite samples of the milk of each cow were collected for each of the ten day periods. This contained ten cc per pound of milk produced. The samples were preserved in glass stoppered bottles with formaldehyde and analyzed by methods given later on.

During each feeding period two men were in attendance at all times to collect the urine and feces. The urine was caught in large buckets, transferred to tightly covered cans and kept until sampled. Every twelve hours the contents of the cans were thoroughly mixed and a sample consisting of 10 cc for each pound of urine was transferred to a glass stoppered bottle, preserved with formaldehyde and this composite sample kept for purposes of analysis.

The feces were caught in specially constructed flat shovels, transferred to tightly covered cans and kept there until sampled every twelve hours after thoroughly mixing the contents of the cans. The composite sample consisted of one gram for each pound of feces. It was preserved by the use of thymol until analyzed.

Analytical Methods

As far as possible, the representative samples of intake and outgo were analyzed according to the official methods of the A. O. A. C. The moisture of all dry ground samples was determined by heating in vacuum at the temperature of boiling water for periods of one hour until constant weights were obtained. With the exceptions that the period of heating was increased to 3 hours and that no reheating was attempted, the water of the urine was determined under similar conditions.

Nitrogen was determined by the Kjeldahl method. The nitrogen of the moist feces was determined by first treating 100 gms. with 250 cc of concentrated acid, then digesting on steam bath for 2 hours. The digested feces were transferred to a liter flask and made up to 1000 cc and shaken thoroughly when 100 cc of the suspension were pipetted for nitrogen analysis by the Kjeldahl digestion method. Triplicate analyses were made. Factor 6.25 was used in all protein calculations except milk protein in which 6.38 was used. With the exception of the nitrogen of the feces, analyses of both feces and silage were made on air dry samples.

The milk fat of Series I was determined by the Adams paper coil method and of Series II by the Babcock centrifugal method. The nitrogen free extract was calculated by taking the difference between the percent of dry matter and the sum of the percentages of protein, ether extract, crude fiber and ash. The casein, albumen, lactose and ash were all determined by the official A. O. A. C. methods.

DISCUSSION OF RESULTS

Nitrogen Balance and Percentage Availability

In Table XXI is offered a comparison of the percentage availability of the nitrogen of oil meal and gluten feed for maintenance. The method used here in calculating the percentage availability is a modification of Thomas' method (U. S. D. A.—B. A. I. Bul. 143). In order to get the maximum nitrogen available for maintenance, the amount of nitrogen contained in the milk produced has been subtracted from the digested nitrogen as suggested in United States Department of Agriculture, Bureau of Animal Industry, Bulletin 143. The digested nitrogen has been considered as the difference between the total intake of nitrogen and that found in the feces. In other words all fecal nitrogen has been regarded as derived from the feed.

The difference between total intake and total outgo of nitrogen, of course, gives the nitrogen balance. The nitrogen balance of Cow 1, Period 1, Series 1, when the cow was on the basal ration was –0.1123 lb. In Period II, Series I, the nitrogen balance of the same cow with the basal ration plus oil meal was –0.0236 lb. This means that the negative nitrogen balance had been decreased by 0.0887 lb. The maximum amount of nitrogen available for maintenance for this cow had increased from –0.0257 lb. in Period I to 0.2051 lb. in Period II or a gain of 0.2308 lb. This 0.2308 lb. feed nitrogen cut down the negative nitrogen balance by only 0.0887 lb. and its percentage availability was therefore $(0.0887 \times 100) \div 0.2308$ or 38.4. In this manner the percentage availability was figured for each cow in the various periods.

Maintenance and Milk Production

In order to do away, if possible, with any error which might be introduced due to the fact that the nitrogen in the milk varied from time to time, Table XXII was prepared. In this table the method of calculating the percentage availability of the feed nitrogen was slightly different. The differences between the nitrogen digested in the basal periods and in the succeeding periods were found. This increased quantity of nitrogen could be used for (neglecting the question of energy) any increased quantity of nitrogen in the milk and for any increase in the store of body nitrogen. In Period II, Series I, Cow I shows an increase in milk nitrogen over the basal period 0.0188 lb. with an increase in the store of body nitrogen of 0.0887 lb. making a total increase of nitrogen of 0.1075 lb. It took 0.2496 lb. of digestible feed nitrogen for

this increase or the percentage availability of the feed nitrogen for maintenance and milk production was 43.1. It will be noted that in this table the availability of the feed nitrogen is calculated as availability for maintenance and milk production while in Table XXI it is calculated as availability for maintenance only. While the two methods give different percentages of availability, they show practically the same results when comparing the availability of the feed nitrogen in the different periods.

The difference between the two methods may be illustrated as follows:

Availability for Maintenance

			Percent Availability
Increase in digested nitrogen 0.2496 lb.	0.0188 lb. nitrogen used for the increase in N in milk.	0.0188 lb.	100
	0.2308 lb. nitrogen used for the increase in body N.	0.0887 lb.	38.4
	0.2496 lb.	0.1075 lb.	

Availability for Maintenance and Milk Production

			Percent Availability
Increase in digested nitrogen 0.2496 lb.	0.0436 lb. nitrogen used for the increase in N in milk	0.0188 lb.	43.1
	0.2060 lb. nitrogen used for the increase in body N.	0.0887 lb.	43.1
	0.2496 lb.	0.1075 lb.	43.1

Basal Ration

The basal ration was not nitrogen-free but was low in protein. According to Armsby (United States Department of Agriculture, Bureau of Animal Industry, Bulletin 143) it has been shown that a relative deficiency of protein in the ration tends to depress the apparent digestibility of both the protein and non-nitrogenous nutrients, especially in the case of ruminants. Hence when the protein content of the rations in this experiment was increased by the addition of either oil meal or gluten feed the digestibility and availability of the nitrogen in the hay and silage were probably increased.

Previous Protein Supply

It is stated by Armsby (United States Department of Agriculture, Bureau of Animal Industry, Bulletin 143) that the plane of protein nutrition is affected by the previous protein supply. The prolonged feeding of a ration low in protein lowers the nitrogen katabolism and this would probably mean that in the period immediately following the basal ration it should not take as much nitrogen to reach a balance as in the later periods. This would tend to make the figures for the percentage availability of the nitrogen in the periods immediately following the basal ration periods higher than those of the succeeding periods. This was not consistently the case so an explanation of the differences in availability of the feed nitrogen must be sought elsewhere.

It must be conceded that the demand for protein to restore body tissues wasted by partial nitrogen starvation would, when the protein of the ration is increased, cause a certain amount of nitrogen to be replaced in the body. A glance at the results of this investigation seem to show that the relatively high availability that might have been expected, due to the prolonged feeding of a ration low in protein, has been more than offset by the protein demands of the body for purposes of rebuilding. This furnishes an explanation for the apparent increase in availability in successive feeding periods.

Digestibility of Nutrients

The digestibility of the nutrients varied in the different periods but seemed to bear no direct relationship to the availability of the feed nitrogen, other factors seeming to counteract any influence which the variation in digestibility may have had.

Weight of Cows

Table XXIII shows the weight of each cow at the beginning and close of the periods together with the gain or loss of

weight. Here again is found no relationship to the availability of the feed nitrogen. It might be expected that a high availability would go with an increase in weight and a low availability with a decrease, but in some instances just the opposite results are found.

Nitrogen in Milk

It will be noted from Tables XXI and XXII that in Periods V and VI of Series I and Period III of Series II the availability of the feed nitrogen is considerably higher than in the other periods of the corresponding series. It will also be noted that in Periods V and VI of Series I and Period III of Series II the amount of nitrogen contained in the milk is less than in the other periods. This probably accounts in part for the higher availability of the feed nitrogen in these periods, when considered along with the question of energy requirements.

Energy Requirements

Table XXIV shows the intake of therms, the therms required for both milk production and maintenance together with the surplus or deficit of therms supplied. In calculating the therms furnished in the feed, Armsby's table was used. His maintenance standard also was used. Armsby adds 0.3 therm for each pound of 4 percent milk produced. Computed on the fat basis this would amount to 7.5 therms for each pound of fat produced. In these tables the therms required for milk production were figured on the basis of the fat produced. It will be noticed by comparing Table XXIV with Tables XXI and XXII that as the surplus of therms increases the availability of the feed nitrogen seems to increase.

In Table XXV is shown the percentage of the total required therms which were found in the hay and silage in the various periods together with the percentage availabilities of the feed nitrogen for maintenance and for milk production and maintenance. These figures seem to show the closest relationship of any. In other words the availability of the feed nitrogen was determined principally by the amount of the required therms furnished by the hay and silage. When the percentage of therms furnished by the hay and silage was low, the protein in the gluten feed or oil meal was used principally as a source of energy and could not be used to build up the body tissue or to furnish milk protein. Therefore the percentage availability of the feed nitrogen was extremely low in these cases.

REVIEW OF LITERATURE

Early investigators in protein feeding, Bousingault 1838, Grouven 1861, Voit 1867, Kuhn and Fleischer 1867-8 and others (Bulletin 45 United States Office of Experiment Stations pp. 265 and following) devoted their energies to a study of the sources of body protein, functions of protein in the body, and the probable manner of digestion and assimilation.

The "nitrogen balance" has long been an object of study. As is well known, it is possible to maintain "nitrogen equilibrium," that is, to feed protein in such quantities that the amount of nitrogen intake equals almost exactly the amount of nitrogen outgo. Investigations have shown that a certain minimum of protein is necessary for body maintenance, regardless of what other nutrients the ration may contain.

It has remained for more recent scientists, Michaud, Thomas Zisterer, Armsby and others (Bulletin 143, Bureau of Animal Industry pp. 102 and following) to carry on investigations wherein proteins were compared for their relative feeding values. Most of these investigations were carried on by feeding pure protein to dogs. Their work is of value to us in this connection chiefly because it suggests methods for measuring relative values.

Michaud, experimenting with dogs, compared the feeding value of ground dog flesh, pure gliadin and pure casein. Gliadin appeared decidedly less valuable in the maintenance of the body protein since it required the addition of a great deal more to the ration in order to maintain nitrogen equilibrium. A second set of experiments, corroborated the conclusions of the first, namely that the vegetable proteins, gliadin and edestin proved notably inferior to the dog flesh or the casein. Although Armsby considers these conclusions open to question in some respects, he nevertheless concedes that in a general way they show the greater value of animal over vegetable protein for feeding carnivorous animals.

Zisterer also experimented with dogs, comparing casein, muscle protein and wheat gluten. He conducted two series of experiments. His work shows a distinct although slight inferiority of the casein as compared to muscle protein. The results on the wheat gluten were discordant in the two series. His results according to Armsby are somewhat inconclusive on the grounds that the so called muscle proteins are not comparable to the pure proteins of the other feeding periods, inasmuch as the muscle protein furnished certain mineral constituents which may have increased the availability of the protein. The work of both Zisterer and Michaud

are qualitative. They show that certain foreign proteins when substituted for tissue caused a relatively greater nitrogen excretion and were therefore less efficient in maintaining the nitrogen equilibrium of the body. It is very possible that the variation in the amount of minerals fed may have had something to do with the apparent greater availability of certain forms of nitrogen.

Thomas prior to 1909 had attempted to determine relative values of the mixed proteins of different feeds by a somewhat different method. He reasoned that by feeding an animal on a nitrogen-free food, determining the amount of nitrogen katabolized and later feeding specific protein substances in addition to the basal non-nitrogenous ration, the relative value of those proteins could be satisfactorily measured according to the amounts by which they reduced the loss of protein from the body. He collected some valuable data on the percentage availability of various protein substances.

Armsby, reviewing the work of the various investigators along this line concludes that, while the results are not in all cases conclusive, they do seem to indicate distinct differences in the nutritive value of proteins. Zein for example fails to produce growth in mice. Zein lacks lysine and tryptophane and since Wilcock and Hopkins have found that the addition of these substances to a protein ration of zein gives the nutrients essential to growth and health, it is only reasonable to conclude that these substances have a definite value aside from the mere maintenance of nitrogen equilibrium. He is of the opinion that certain proteins and their cleavage products are vital to proper nutrition but does not admit the inability of one protein or its amino acid to change to that of another should one of these essential proteins be lacking in quantity.

Armsby (Bulletin 139, Bureau of Animal Industry) summarizing the experiments of Lehmann, Kellner, Just, Morgen and the Copenhagen Laboratory of Agricultural Research states that generally speaking it appears that some non-protein nitrogenous substances taken into the body in the feed are metabolized and to a certain extent are capable of performing the functions of the protein. In ruminants the action of micro-organisms in the digestive tract appear to convert some non-protein nitrogen (usually amino acids and amides) into protein, which may serve for maintenance and as a source of milk protein and probably for growth.

Van Ewing and Wells (Georgia, Buls. 109 and 115) secured data showing that as the plane of nutrition is raised so is the apparent digestibility of the nutrients. They also con-

cluded that the addition of starch to a ration caused considerable decrease in the apparent digestibility of the nitrogen.

Ellett and Holdaway (Virginia Tech. Bulletin 12) comparing milk cows fed a high energy ration and a high protein ration found that a cow receiving a high energy ration, decreased in milk production and body weight, and that the apparent digestibility of the protein decreased 47%. The cow fed on a high protein ration did not consume all her feed and yet the amount consumed furnished all the required energy and two and one-half times the required amount of protein, and this excess protein was digested. The apparent digestibility of the nutrients agreed quite closely with the average coefficients. They concluded that the addition of protein to a ration increases the digestibility of all nutrients.

Osborne and Mendel (Jour. Biol. Chem. Feb. 1917) experimented in feeding rats various forms of protein in addition to a basal ration of corn gluten. They found lactalbumin to be the most efficient supplement. The least efficient supplements, brewers grain, distillers grains and "vegetable albumin flour" were presumably so because of their low content of lysine.

Ewing, Ridgeway and Doubt (Bulletin 238, Texas Exp. Station) comparing the feeding value of peanut meal and cottonseed meal conclude that the total digestible nutrients offer a better method of comparing feeds for dairy cows than does the protein content. They further conclude that a mixture of the two feeds compared furnishes a more satisfactory ration than either feed if fed alone.

From the above digest of literature dealing with the subject it would seem that certain acceptable conclusions stand out clearly.

1. What is popularly termed "protein" is a complex substance consisting of several simpler substances, certain quantities of each of which are necessary to supply body needs.

2. There is a possibility of one protein undergoing changes to supply entirely or in part, the substances ordinarily furnished by another form of protein, altho it is doubtful if one protein can replace another entirely.

3. Protein when fed in excessive quantities may furnish energy to the body, especially when the ration as a whole is low in non-nitrogenous nutrients.

4. There is no known method whereby a ration deficient in nitrogen can be made proficient by the addition of excessive quantities of various non-nitrogenous nutrients. A cer-

tain minimum of protein or non-protein nitrogenous substances is absolutely necessary for maintenance and production, if the body is to continue its activity without loss of weight.

5. Methods of measuring relative values of proteins are few and for the most part unsatisfactory.

6. It is difficult to measure the effects of non-nitrogenous nutrients in the feeds.

7. The fat of milk probably derives a part of its substance from protein. To what extent it is difficult to determine.

8. The availability of food nutrients probably varies with different cows.

9. The availability of food nutrients probably varies with the same cow at different times.

10. Apparently the most plausible method thus far suggested for measuring relative values of protein feeds is to give the cows the various feeds successively and make observation on the effectiveness with which these feeds establish and maintain nitrogen equilibrium. This necessitates of course the elimination as far as possible of all other factors which might effect the results.

SUMMARY

1. The question of the proper interpretation of results obtained from substituting one protein feed for another in the ration of a cow producing milk is a difficult one.

2. Because of other factors which might affect the results, (the most important of which are probably energy supply and variations in production of milk) it cannot be said that the most valuable protein is always the one which in least quantity establishes and maintains approximate nitrogen equilibrium.

3. Unless the energy content of the ration is abundant a part of the protein will probably go to satisfy energy requirements rather than nitrogen requirements.

4. Average percent availability of oil meal and gluten food in establishing a nitrogen equilibrium was oil meal 52.4 percent and gluten feed 76.4 percent or as 1 is to 1.46.

5. In all but two instances gluten feed protein seems to show a higher relative value than oil meal protein. This higher value, however, may be due not necessarily to the source of the protein, but possibly in part to the increased percentage of therms net energy in the hay and silage.

REFERENCES

1. "The Scientific Feeding of Animals," Kellner-Goodwin (1908)
2. "The Science of Nutrition," Graham Lusk (1909)
3. "Feeds and Feeding" Henry and Morrison (1915)
4. "Annual Report Maine Exp. Sta. pp 24-77 (1895)
5. Bulletin 132, Geneva, New York Exp. Sta. (1897)
6. Bulletin 45, Office of Experiment Stations, pp 285-300 (1898)
7. Bulletin 156, Virginia Exp. Sta. (1905)
8. Farmers Bulletin No. 346, U. S. Dept. of Agr. H. P. Armsby (1909)
9. Research Bulletin No. 13, Wisconsin Exp. Sta. (1910)
10. Research Bulletin No. 17, Wisconsin Exp. Sta. (1911)
11. Bulletin 139, Bureau of Animal Industry, H. P. Armsby (1912)
12. Bulletin 143, Bureau of Animal Industry, H. P. Armsby (1912)
13. Research Bulletin No. 7 Missouri Exp. Sta. (1913)
14. Tech. Bulletin No. 12, Virginia Exp. Sta. (1915)
15. Bulletin 109, Georgia Exp. Sta. (1916)
16. Bulletin 115, Georgia Exp. Sta. (1916)
17. Jour. Agr. Research Vol. 7; No. 7, pp 301-320 (1916)
18. Agricultural Gazette of Canada, Vol. 3; pp 687-692 (1916)
19. Journ. Biological Chemistry, XXIX pp 69-92 (Feb. 1917)
20. Bulletin 125, Georgia Exp. Sta. (1917)
21. Bulletin 203, Purdue Exp. Sta. (1917)
22. Bulletin 238, Texas Exp. Sta. (1918)

TABLE I.
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD I

	Intake			Outgo								
				Feces			Urine			Milk		
	Hay	Silage	Water	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	5.73	75.72	99.92	85.64	84.28	85.78	92.60	92.50	93.02	Moisture	88.34	87.15	88.52
Total Nitrogen	0.897	0.347	.....	0.327	0.241	0.211	0.567	0.536	0.473	Total Nitrogen	0.435	0.494	0.431
Total Protein.	5.62	2.17	.....	2.04	1.51	1.32	.....	.....	.....	Total Protein	2.78	3.15	2.75
Ether Extract	2.38	0.29	.....	0.49	0.51	0.47	.....	.....	.....	Fat	3.89	4.27	3.59
Crude Fiber..	33.17	6.54	.....	4.12	4.74	4.32	.....	.....	.....	Lactose	4.35	4.70	4.50
N-free Extract	45.76	13.23	0.0126	5.41	6.44	5.95	.....	.....	.....	Ash	0.65	0.70	0.64
Ash	7.34	2.05	0.0635	2.30	2.52	2.16	3.17	3.33	3.09				

TABLE II
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD II

	Intake			Outgo								
				Feces			Urine			Milk		
	Hay	Silage	Oil Meal	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	7.82	77.63	9.34	85.43	85.26	85.22	93.49	92.17	92.75	Moisture	89.54	87.62	88.61
Total Nitrogen	1.016	0.361	5.119	0.282	0.289	0.273	1.192	1.139	0.943	Total Nitrogen	0.440	0.475	0.450
Total Protein	6.35	2.26	31.99	1.76	1.81	1.71	.....	.....	.....	Total Protein	2.81	3.03	2.87
Ether Extract	2.06	0.80	5.83	0.29	0.29	0.29	.....	.....	.....	Fat	3.36	3.91	3.58
Crude Fiber..	30.90	6.35	9.26	4.46	4.35	4.24	.....	.....	.....	Lactose	4.50	5.10	4.25
N-free Extract	45.33	11.00	37.72	6.00	6.15	6.45	.....	.....	.....	Ash	0.77	0.68	0.68
Ash	7.54	1.96	5.86	2.06	2.14	2.09	2.85	3.22	3.00				

TABLE III.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES I PERIOD I

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Hay	11.59	0.649	10.925	0.1040	0.6513	0.2578	3.844	5.304	0.8507
		Silage	30.00	22.716	7.284	0.1041	0.6514	0.0870	1.962	3.969	0.6150
		Water and Salt.	60.22	60.114	0.108	.....	.....	.....	.....	.....	0.1007
		Total Intake ...	101.81	83.479	18.317	0.2081	1.3027	0.3628	5.806	9.273	1.5664
	Outgo	Milk	23.09	20.398	2.692	0.1004	0.6409	0.8982	.....	1.004	0.1501
		Urine	15.27	14.140	1.130	0.0866	.....	.....	.....	.....	0.4841
		Feces	40.81	34.946	5.859	0.1334	0.8341	0.2000	1.681	2.208	0.9385
		Total Outgo	79.17	69.484	9.681	0.3204	1.4750	1.0982	1.681	3.212	1.5727
		Balance	+22.64	+13.995	+8.636	−0.1123	.....	−0.7364	+4.125	+6.061	−0.0063
Cow 2	Intake	Hay	13.21	0.757	12.453	0.1185	0.7424	0.3144	4.382	6.045	0.9696
		Silage	30.00	22.716	7.284	0.1041	0.6514	0.0874	1.962	3.969	0.6150
		Water and Salt.	70.85	70.736	0.116	.....	.....	.....	.....	.....	0.1074
		Total Intake ...	114.06	94.209	19.853	0.2226	1.3938	0.4018	6.344	10.014	1.6920
	Outgo	Milk	20.71	18.049	2.661	0.1023	0.6524	0.8843	.....	0.973	0.1450
		Urine	15.11	13.976	1.134	0.0810	.....	.....	.....	.....	0.5032
		Feces	52.03	43.851	8.179	0.1254	0.7836	0.2654	2.466	3.351	1.3110
		Total Outgo ...	87.85	75.876	11.974	0.3087	1.4360	1.1497	2.466	4.324	1.9592
		Balance	+26.21	+18.333	+7.879	−0.0861	.....	+0.7479	+3.878	+5.790	−0.2672
Cow 3	Intake	Hay	13.80	0.791	13.009	0.1238	0.7756	0.3284	4.577	6.315	1.0129
		Silage	30.00	22.716	7.284	0.1041	0.6514	0.0874	1.962	3.969	0.6150
		Water and Salt.	72.52	72.405	0.117	.....	.....	.....	.....	.....	0.1085
		Total Intake ...	116.32	95.912	20.410	0.2279	1.4270	0.4158	6.539	10.284	1.7364
	Outgo	Milk	21.13	18.705	2.426	0.0911	0.5811	0.7586	.....	0.951	0.1352
		Urine	17.00	15.817	1.183	0.0804	.....	.....	.....	.....	0.5253
		Feces	63.65	54.600	9.050	0.1343	0.8389	0.2992	2.743	3.787	1.3620
		Total Outgo	101.78	89.122	12.659	0.3058	1.4199	1.0578	2.743	4.738	2.0225
		Balance	+14.54	+6.790	+7.752	−0.0779	.....	−0.6420	+3.796	+5.546	−0.2861

TABLE IV.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES I PERIOD II

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Oil Meal	5.00	0.467	4.533	0.2559	1.5995	0.2915	0.463	1.886	0.2930
		Hay	12.04	0.941	11.099	0.1223	0.7645	0.2480	3.720	5.458	0.9078
		Silage	30.00	23.289	6.711	0.1083	0.6780	0.2400	1.905	3.300	0.5880
		Water and Salt.	71.68	71.565	0.116	.....	.....	.....	.....	.....	0.1080
		Total Intake ...	118.72	96.262	22.459	0.4865	3.0420	0.7795	6.088	10.644	1.8968
	Outgo	Milk	27.10	24.266	2.835	0.1192	0.7615	0.9106	.....	1.219	0.2087
		Urine	19.19	17.942	1.239	0.2287	.....	.....	.....	.....	0.5469
		Feces	57.50	49.122	8.378	0.1622	1.0120	0.1668	2.564	3.450	1.1845
		Total Outgo	103.79	91.330	12.452	0.5101	1.7735	1.0774	2.564	4.669	1.9401
		Balance	+14.93	+4.932	+10.007	−0.0236	.....	−0.2979	+3.524	+5.975	−0.0433
Cow 2	Intake	Oil Meal	4.00	0.374	3.626	0.2048	1.280	0.2332	0.370	1.489	0.2344
		Hay	15.16	1.185	13.974	0.1540	0.963	0.3123	4.684	6.872	1.1430
		Silage	30.00	23.289	6.711	0.1083	0.678	0.2400	1.905	3.300	0.5880
		Water and Salt.	74.00	73.884	0.118	.....	.....	.....	.....	.....	0.1091
		Total Intake ...	123.16	98.732	24.429	0.4671	2.921	0.7855	6.959	11.661	2.0748
	Outgo	Milk	22.74	19.924	2.815	0.1080	0.6890	0.8891	.....	1.160	0.1546
		Urine	18.12	16.701	1.419	0.2064	.....	.....	.....	.....	0.6209
		Feces	60.49	51.574	8.916	0.1748	1.0949	0.1754	2.631	3.720	1.2944
		Total Outgo ...	101.35	88.199	13.150	0.4892	1.7839	1.0645	2.631	4.880	2.0699
		Balance	+21.81	+10.533	+11.279	−0.0221	.....	−0.2790	+4.328	+6.781	+0.0049
Cow 3	Intake	Oil Meal	3.50	0.327	3.173	0.1792	1.1200	0.2041	0.324	1.320	0.2051
		Hay	15.22	1.190	14.030	0.1546	0.9665	0.3135	4.703	6.899	1.1476
		Silage	30.00	23.289	6.711	0.1083	0.6780	0.2400	1.905	3.300	0.5880
		Water and Salt.	83.52	83.400	0.122	.....	.....	.....	.....	.....	0.1155
		Total Intake ...	132.24	108.206	24.036	0.4421	2.7645	0.7576	6.932	11.519	2.0562
	Outgo	Milk	25.20	22.330	2.870	0.1134	0.7232	0.9022	.....	1.071	0.1714
		Urine	19.03	17.643	1.380	0.1795	.....	.....	.....	.....	0.5709
		Feces	64.88	55.290	9.590	0.1771	1.1094	0.1882	2.751	4.185	1.3560
		Total Outgo ...	109.11	95.263	13.840	0.4700	1.8326	1.0904	2.751	5.256	2.0983
		Balance	+23.13	+12.943	+10.196	−0.0279	.....	−0.3328	+4.181	+6.263	−0.0421

TABLE V.
DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES 1 PERIOD III

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Oil Meal	6.00	0.613	5.387	0.3354	2.096	0.0516	0.518	2.378	0.3420
		Hay	15.20	1.296	13.904	0.1629	1.018	0.3710	4.657	7.162	1.2357
		Silage	30.00	23.289	6.711	0.1083	0.678	0.2400	1.905	3.300	0.5880
		Water and Salt.	82.52	82.398	0.124	.....	.....	.....	.....	.....	0.1113
		Total Intake ...	133.72	107.596	26.126	0.6066	3.792	0.6626	7.080	12.830	2.2760
	Outgo	Milk	28.26	24.973	3.287	0.1322	0.845	1.0513	.....	1.130	0.2091
		Urine	18.68	17.544	1.136	0.2430	.....	.....	.....	.....	0.6967
		Feces	65.40	55.695	9.705	0.1890	1.183	0.2551	2.086	3.163	1.3930
		Total Outgo	112.34	98.212	14.128	0.5642	2.028	1.3064	2.086	4.293	2.2988
		Balance	+21.38	+9.384	+11.998	+0.0424	.....	−0.6438	+4.994	+8.537	−0.0228
Cow 2	Intake	Oil Meal	5.00	0.511	4.489	0.2795	1.747	0.0430	0.432	1.982	0.2850
		Hay	16.24	1.385	14.855	0.1741	1.088	0.3963	4.970	7.652	1.3203
		Silage	30.00	23.289	6.711	0.1083	0.678	0.2400	1.905	3.300	0.5880
		Water and Salt.	90.02	89.883	0.139	.....	.....	.....	.....	.....	0.1147
		Total Intake ...	141.26	115.068	26.194	.5619	3.513	0.6793	7.307	12.934	2.3080
	Outgo	Milk	25.20	22.105	3.096	0.1202	0.766	0.9500	.....	1.134	0.1714
		Urine	16.88	15.734	1.146	0.2129	.....	.....	.....	.....	0.6262
		Feces	71.26	60.993	10.267	0.2009	1.254	0.2218	2.865	4.440	1.4895
		Total Outgo	113.34	98.832	14.509	0.5340	2.020	1.1718	2.865	5.574	2.2871
		Balance	+27.92	+16.236	+11.685	+0.0279	.....	−0.2218	+4.442	+6.360	+0.0209
Cow 3	Intake	Oil Meal	4.50	0.460	4.040	0.2515	1.572	0.0387	0.389	1.684	0.2565
		Hay	15.82	1.350	14.470	0.1700	1.060	0.3860	4.841	7.454	1.2860
		Silage	30.00	23.289	6.711	0.1083	0.678	0.2400	1.905	3.300	0.5880
		Water and Salt.	87.26	87.135	0.127	.....	.....	.....	.....	.....	0.1131
		Total Intake ...	137.58	112.234	25.348	0.5298	3.310	0.6647	7.135	12.438	2.2436
	Outgo	Milk	26.62	23.506	3.114	0.1251	0.799	0.9796	.....	1.145	0.1943
		Urine	18.30	17.019	1.281	0.2083	.....	.....	.....	.....	0.7649
		Feces	73.86	63.300	10.560	0.2061	1.285	0.2142	3.058	4.535	1.4700
		Total Outgo	118.78	103.825	14.955	0.5395	2.084	1.1938	3.058	5.680	2.4292
		Balance	+18.80	+8.409	+10.393	−0.0097	.....	−0.5291	+4.077	+6.785	−0.1856

TABLE VI.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES I PERIOD IV

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Oil Meal	6.20	0.603	5.597	0.3543	2.214	0.1091	0.543	2.988	0.3435
		Hay	13.05	1.010	12.040	0.1648	1.029	0.1540	3.742	5.998	1.1197
		Silage	30.00	22.665	7.335	0.0921	0.576	0.1740	1.980	3.990	0.5850
		Water and Salt.	92.50	92.371	0.131	.....	.....	.....	.....	.....	0.1160
		Total Intake ...	141.75	116.649	25.103	0.6112	3.819	0.4371	6.265	12.976	2.1642
	Outgo	Milk	25.29	22.356	2.934	0.1191	0.759	1.0120	.....	0.961	0.1897
		Urine	24.65	23.371	1.279	0.2995	.....	.....	.....	.....	0.5226
		Feces	65.07	56.253	8.817	0.1822	1.139	0.1236	2.609	3.579	1.3014
		Total Outgo	115.01	101.980	13.030	0.6008	1.898	1.1356	2.609	4.540	2.0137
		Balance	+26.74	+14.669	+12.073	+0.0104	.....	−0.6985	+3.656	+8.436	+0.1505
Cow 2	Intake	Oil Meal	5.80	0.564	5.234	0.3314	2.071	0.1021	0.508	2.234	0.3213
		Hay	16.65	1.289	15.361	0.2103	1.314	0.1965	4.735	7.648	1.4286
		Silage	30.00	22.665	7.335	0.0921	0.576	0.1740	1.980	3.990	0.5850
		Water and Salt.	91.03	90.908	0.130	.....	.....	.....	.....	.....	0.1153
		Total Intake ...	143.48	115.426	28.060	0.6338	3.961	0.3726	7.223	13.972	2.4502
	Outgo	Milk	22.95	20.212	2.738	0.1106	0.705	0.8606	.....	1.067	0.1584
		Urine	19.01	17.675	1.335	0.2753	.....	.....	.....	.....	0.5817
		Feces	68.94	59.017	9.928	0.1868	1.165	0.1310	2.765	3.792	1.5030
		Total Outgo	110.90	96.904	14.001	0.5727	1.870	0.9916	2.765	4.859	2.2431
		Balance	+32.58	+18.522	+14.059	+0.0611	.....	−0.6190	+4.458	+9.113	+0.2071
Cow 3	Intake	Oil Meal	6.00	0.583	5.417	0.3428	2.143	0.1056	0.526	2.311	0.3324
		Hay	14.30	1.107	13.193	0.1806	1.128	1.6874	4.100	3.405	1.2270
		Silage	30.00	22.665	7.335	0.0921	0.576	0.1740	1.980	3.990	0.5850
		Water and Salt.	100.79	100.655	0.137	.....	.....	.....	.....	.....	0.1169
		Total Intake ...	151.09	125.010	26.082	0.6155	3.847	1.3483	6.606	9.706	2.2613
	Outgo	Milk	26.82	23.733	3.087	0.1277	0.818	0.9628	.....	1.127	0.1931
		Urine	23.51	22.186	1.324	0.2722	.....	.....	.....	.....	0.6230
		Feces	74.30	65.451	8.849	0.2162	1.352	0.1412	2.653	3.403	1.3003
		Total Outgo	124.63	111.370	13.260	0.6161	2.170	1.1040	2.653	4.530	2.1164
		Balance	+26.46	+13.640	+12.822	−0.0006	.....	−0.7557	+3.953	+5.176	+0.1449

TABLE VII.
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD III

	Intake			Outgo									
				Feces			Urine			Milk			
	Hay	Silage	Oil Meal	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	8.53	77.63	10.22	85.16	85.59	85.70	93.92	93.21	93.00	Moisture	88.37	87.72	88.30
Total Nitrogen	1.072	0.361	5.590	0.289	0.282	0.279	1.301	1.261	1.138	TotalNitrogen	0.468	0.477	0.470
Total Protein	6.70	2.26	34.94	1.81	1.76	1.74	.....	.....	.....	Total Protein	2.99	3.04	3.00
Ether Extract	2.44	0.80	0.86	0.39	0.31	0.29	.....	.....	.....	Fat	3.72	3.77	3.68
Crude Fiber..	30.60	6.35	8.64	3.19	4.02	4.14	.....	.....	.....	Lactose	4.00	4.50	4.30
N-free Extract	43.50	11.00	39.64	7.32	6.23	6.14	.....	.....	.....	Ash	0.74	0.68	0.73
Ash	8.13	1.96	5.70	2.13	2.09	1.99	3.73	3.70	4.18				

TABLE VIII
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD IV.

	Intake			Outgo									
				Feces			Urine			Milk			
	Hay	Silage	Oil Meal	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	7.74	75.55	9.72	86.45	85.60	88.09	94.81	92.98	94.37	Moisture	88.40	88.07	88.49
Total Nitrogen	1.263	0.307	5.714	0.280	0.271	0.291	1.215	1.448	1.158	TotalNitrogen	0.471	0.482	0.476
Total Protein	7.89	1.92	35.71	1.75	1.69	1.82	.....	.....	.....	Total Protein	3.00	3.07	3.05
Ether Extract	1.18	0.58	1.76	0.19	0.24	0.19	.....	.....	.....	Fat	4.00	3.75	3.59
Crude Fiber..	28.67	6.60	8.76	4.01	3.84	3.57	.....	.....	.....	Lactose	3.80	4.65	4.20
N-free Extract	45.94	13.30	38.51	5.50	6.45	4.58	.....	.....	.....	Ash	0.75	0.69	0.72
Ash	8.58	1.95	5.54	2.00	2.18	1.75	2.12	3.06	2.65				

TABLE IX.
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD V.

	Intake			Outgo									
				Feces			Urine			Milk			
	Hay	Silage	Gluten Feed	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	7.75	77.19	7.00	87.46	87.18	86.95	91.88	91.37	93.03	Moisture	88.70	87.46	88.57
Total Nitrogen	1.345	0.334	3.418	0.322	0.322	0.322	0.907	1.039	0.774	TotalNitrogen	0.458	0.534	0.476
Total Protein	8.41	2.09	21.36	2.01	2.01	2.01	.....	.....	.....	Total Protein	2.92	3.41	3.04
Ether Extract	2.21	0.70	0.77	0.40	0.38	0.33	.....	.....	.....	Fat	3.25	3.75	3.41
Crude Fiber..	27.68	6.71	7.64	3.19	3.42	4.80	.....	.....	.....	Lactose	4.30	4.80	4.30
N-free Extract	44.26	11.40	60.12	4.96	4.99	3.94	.....	.....	.....	Ash	0.74	0.69	0.71
Ash	9.69	1.91	3.11	1.98	2.02	1.97	3.00	3.40	3.10				

TABLE X.
COMPOSITION OF INTAKE AND OUTGO SERIES I PERIOD VI.

	Intake			Outgo									
				Feces			Urine			Milk			
	Hay	Silage	Gluten Feed	Cow 1	Cow 2	Cow 3	Cow 1	Cow 2	Cow 3		Cow 1	Cow 2	Cow 3
Moisture	6.61	77.19	7.22	87.44	86.56	86.23	92.96	92.72	93.10	Moisture	89.04	87.78	88.27
Total Nitrogen	1.205	0.334	3.412	0.302	0.307	0.314	0.647	0.727	0.599	TotalNitrogen	0.476	0.504	0.462
Tot l Protein	7.54	2.09	21.32	1.89	1.92	1.96	.....	.....	.....	Total Protein	2.98	3.15	2.95
Ether Extract	1.24	0.70	0.94	0.20	0.23	0.19	.....	.....	.....	Fat	3.19	3.73	3.66
Crude Fiber.	20.96	6.71	7.60	3.32	3.62	4.09	.....	.....	.....	Lactose	4.00	4.70	4.40
N-free Extract	55.93	11.40	59.84	5.43	5.85	5.73	.....	.....	.....	Ash	0.75	0.68	0.73
Ash	7.72	1.91	3.08	1.72	1.82	1.80	3.12	3.50	3.13				

TABLE XI.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES I PERIOD V

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Gluten Feed	6.00	0.420	5.580	0.2051	1.282	0.0462	0.458	3.607	0.1866
		Hay	14.28	1.107	13.173	0.1931	1.207	0.3156	3.952	6.250	1.3837
		Silage	30.00	23.157	6.843	0.1001	0.627	0.2100	2.013	4.047	0.5730
		Water and Salt.	70.24	70.128	0.114	.....	.....	.....	.....	.....	0.1095
		Total Intake ...	120.52	94.812	25.710	0.4983	3.116	0.5718	6.423	13.904	2.2528
	Outgo	Milk	23.04	20.436	2.604	0.1055	0.673	0.7488	.....	0.991	0.1705
		Urine	17.22	15.822	1.398	0.1562	.....	.....	.....	.....	0.5166
		Feces	57.50	50.290	7.210	0.1848	1.156	0.2300	1.834	2.852	1.1385
		Total Outgo	97.76	86.548	11.212	0.4465	1.829	0.9788	1.834	3.843	1.8256
		Balance	+22.76	+8.264	+14.498	+0.0518	.....	−0.4070	+4.589	+10.061	+0.4272
Cow 2	Intake	Gluten Feed	6.00	0.420	5.580	0.2051	1.282	0.0462	0.458	3.607	0.1866
		Hay	14.30	1.108	13.192	0.1933	1.208	0.3160	3.958	6.330	1.3857
		Silage	30.00	23.157	6.843	0.1001	0.627	0.2100	2.013	4.047	0.5730
		Water and Salt.	74.64	74.524	0.118	.....	.....	.....	.....	.....	0.1058
		Total Intake ...	124.94	99.209	25.733	0.4985	3.117	0.5722	6.429	13.984	2.2511
	Outgo	Milk	20.46	17.894	2.566	0.1093	0.698	0.7673	.....	0.982	0.1412
		Urine	15.22	13.906	1.314	0.1581	.....	.....	.....	.....	**0.5175**
		Feces	60.00	52.308	7.692	0.1933	1.206	0.2280	2.052	2.994	1.2120
		Total Outgo	95.68	84.108	11.572	0.4607	1.904	0.9953	2.052	3.976	1.8707
		Balance	+29.26	+15.101	+14.161	+0.0378	.....	−0.4231	+4.377	+10.008	+0.3804
Cow 3	Intake	Gluten Feed	6.00	0.420	5.580	0.2051	1.282	0.0462	0.458	3.607	0.1866
		Hay	14.92	1.156	13.764	0.2007	1.573	0.3297	4.130	6.604	1.4457
		Silage	30.00	23.157	6.843	0.1001	0.627	0.2100	2.013	4.047	0.5730
		Water and Salt.	96.92	96.787	0.135	.....	.....	.....	.....	.....	0.1187
		Total Intake ...	147.84	121.520	26.322	0.5059	3.482	0.5859	6.601	14.258	2.3374
	Outgo	Milk	23.38	20.712	2.678	0.1113	0.711	0.7972	.....	1.005	0.1660
		Urine	20.18	18.774	1.406	0.1562	.....	.....	.....	.....	0.6256
		Feces	68.60	59.648	8.952	0.2209	1.379	0.2264	3.293	2.793	1.3514
		Total Outgo ...	112.16	99.134	13.036	0.4884	2.090	1.0236	3.293	3.798	2.1430
		Balance	+35.68	+22.386	+13.286	+0.0175	.....	−0.5377	+3.308	+10.460	+0.1944

TABLE XII.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES I PERIOD VI

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Gluten Feed	4.00	0.289	3.711	0.1365	0.853	0.0376	0.304	2.394	0.1232
		Hay	16.00	1.058	14.942	0.1928	1.206	0.1984	3.354	8.949	1.2352
		Silage	30.00	23.157	6.843	0.1002	0.627	0.2100	2.013	4.047	0.5730
		Water and Salt.	82.84	82.718	0.124	.....	.....	.....	.....	.....	0.1105
		Total Intake ...	132.84	108.222	25.620	0.4295	2.686	0.4450	5.671	15.390	2.0419
	Outgo	Milk	20.80	18.520	2.280	0.0990	0.620	0.6635	.....	0.832	0.1560
		Urine	19.72	18.332	1.388	0.1276	.....	.....	.....	.....	0.6153
		Feces	58.64	51.274	7.366	0.1771	1.108	0.1173	1.947	3.184	1.0086
		Total Outgo	99.16	88.216	11.034	0.4037	1.728	0.7808	1.947	4.016	1.7799
		Balance	+33.68	+20.096	+14.586	+0.0258	.....	−0.3308	+3.697	+11.374	+0.2620
Cow 2	Intake	Gluten Feed	4.50	0.325	4.175	0.1535	0.959	0.0513	0.342	2.693	0.1386
		Hay	16.30	1.077	15.223	0.1964	1.229	0.2021	3.416	9.117	1.2583
		Silage	30.00	23.157	6.843	0.1002	0.627	0.2100	2.013	4.047	0.5730
		Water and Salt.	83.90	83.717	0.125	.....	.....	.....	.....	.....	0.1111
		Total Intake ...	134.70	108.276	26.366	0.4501	2.815	0.4634	5.771	15.857	2.0810
	Outgo	Milk	18.74	16.450	2.290	0.0944	0.590	0.6990	.....	0.879	0.1274
		Urine	18.62	17.246	1.354	0.1352	.....	.....	.....	.....	0.6517
		Feces	59.62	51.607	8.013	0.1830	1.145	0.1371	2.158	3.486	1.0851
		Total Outgo	96.98	85.303	11.657	0.4126	1.735	0.8461	2.158	4.365	1.8642
		Balance	+37.72	+22.973	+14.709	+0.0375	.....	−0.3727	+3.613	+11.492	+0.2168
Cow 3	Intake	Gluten Feed ...	3.60	0.260	3.340	0.1228	0.768	0.0339	0.274	2.154	0.1109
		Hay	16.58	1.096	15.484	0.1998	1.250	0.2056	3.475	9.273	1.2800
		Silage	30.00	23.157	6.843	0.1002	0.627	0.2100	2.013	4.047	0.5780
		Water and Salt.	91.62	91.491	0.131	.....	.....	.....	.....	.....	0.1156
		Total Intake ...	141.80	116.004	25.798	0.4228	2.645	0.4495	5.762	15.474	2.0795
	Outgo	Milk	20.36	17.964	2.386	0.0941	0.601	0.7452	.....	0.896	0.1486
		Urine	20.58	19.160	1.420	0.1233	.....	.....	.....	.....	0.6442
		Feces	63.02	54.342	8.678	0.1979	1.235	0.1197	2.578	3.611	1.1344
		Total Outgo ...	103.96	91.466	12.484	0.4153	1.836	0.8649	2.578	4.507	1.9272
		Balance	+37.84	+24.538	+13.314	+0.0075	.....	−0.3154	+3.184	+10.967	+0.1523

TABLE XIII.
COMPOSITION OF INTAKE AND OUTGO SERIES II PERIOD I

	Intake		Refuse				Feces				Urine			
	Hay	Silage	Cow 1	Cow 2	Cow 3	Cow 4*	Cow 1	Cow 2	Cow 3	Cow 4	Cow 1	Cow 2	Cow 3	Cow 4
Water	7.25	71.61	6.68	7.39	7.89	.....	81.32	84.38	85.12	84.43	91.27	91.51	91.65	93.21
Dry Matter	92.75	28.39	93.16	92.61	92.11	.....	18.68	15.62	14.88	15.57	8.73	8.49	8.35	6.79
Nitrogen	1.07	0.394	1.243	1.243	1.214	.....	0.287	0.255	0.244	0.238	0.619	0.66	0.615	0.46
Crude Protein	6.66	2.45	7.77	7.77	6.58	.....	1.79	1.595	1.52	1.49	.....	.....	.....	.....
Ether Extract	1.94	0.74	2.32	2.42	2.50	.....	0.44	0.50	0.35	0.41	.....	.....	.....	.....
Crude Fiber	31.23	6.64	31.58	31.47	30.54	.....	5.68	4.55	4.84	4.79	.....	.....	.....	.....
N-free Extract	45.25	16.18	42.70	42.11	43.76	.....	8.02	6.59	6.00	2.27	.....	.....	.....	.....
Ash	7.67	2.38	8.79	8.84	8.73	.....	2.75	2.39	2.17	6.62	3.82	3.74	3.80	2.88

TABLE XIII.—(Continued)

	Milk			
	Cow 1	Cow 2	Cow 3	Cow 4
Water	89.77	88.00	88.12	87.78
Nitrogen	0.412	0.412	0.402	0.429
Total Protein	2.63	2.63	2.57	2.74
Fat	2.25	3.60	2.20	2.85
Lactose	4.84	5.02	6.43	5.89
Ash	0.765	0.75	0.689	0.736

*Cow 4, no refuse

TABLE XIV.
COMPOSITION OF INTAKE AND OUTGO SERIES II PERIOD II

	Intake				Refuse				Feces			
	Hay	Silage	Oil Meal	Gluten Feed	Cow 1	Cow 2	Cow 3	Cow 4	Cow 1	Cow 2	Cow 3	Cow 4
Water	7.85	72.94	10.15	8.48	5.80	6.18	5.58	5.99	82.67	84.94	83.74	84.84
Dry Matter	92.15	27.06	89.85	91.52	94.20	93.82	94.42	94.01	17.33	15.06	16.26	15.19
Nitrogen	1.003	0.414	5.92	4.04	1.037	1.489	1.128	1.224	0.278	0.216	0.275	0.226
Crude Protein	6.27	2.65	37.00	25.22	6.48	9.31	7.06	7.65	1.74	1.35	1.72	1.41
Ether Extract	2.25	0.77	5.68	4.80	1.68	1.84	1.87	1.72	0.21	0.23	0.23	0.33
Crude Fiber	31.29	5.57	8.17	3.79	33.53	35.23	33.55	32.55	5.14	4.55	5.09	4.65
N-free Extract	45.04	16.23	33.38	53.83	45.26	38.39	44.05	44.06	7.73	6.94	7.05	6.72
Ash	7.30	1.75	5.62	3.88	7.25	9.05	7.89	8.03	2.51	1.99	2.17	2.08

TABLE XIV. (Continued)

	Urine					Milk			
	Cow 1	Cow 2	Cow 3	Cow 4		Cow 1	Cow 2	Cow 3	Cow 4
Water	90.85	91.40	92.08	92.22	Water	89.47	87.67	88.17	87.89
Dry Matter	9.15	8.60	7.92	7.78	Nitrogen	0.384	0.488	0.442	0.428
Nitrogen	0.612	0.668	0.705	0.434	Total Protein	2.50	3.11	2.82	2.73
Crude Protein	.....	.....	.....	.....	Fat	3.16	3.52	3.28	3.22
Ether Extract	.....	.....	.....	.....	Lactose	4.07	4.98	5.01	5.58
Crude Fiber	.....	.....	.....	.....	Ash	0.78	0.74	0.72	0.67
N-free Extract	.....	.....	.....	.....					
Ash	3.96	3.78	3.46	3.39					

TABLE XV.
COMPOSITION OF INTAKE AND OUTGO SERIES II PERIOD III

	Intake				Refuse				Feces			
	Hay	Silage	Oil Meal	Gluten Feed	Cow 1	Cow 2	Cow 3	Cow 4	Cow 1	Cow 2	Cow 3	Cow 4
Water	16.37	72.94	10.15	8.48	13.93	15.17	12.48	11.62	82.33	82.33	83.62	80.01
Dry Matter	83.63	27.06	89.85	91.52	86.07	84.83	87.52	88.38	17.67	17.67	16.38	19.99
Nitrogen	0.913	0.414	5.92	4.04	0.905	0.989	1.05	0.901	0.243	0.249	0.234	0.201
Crude Protein	5.70	2.65	37.00	25.22	5.65	6.18	6.56	5.63	1.52	1.56	1.46	1.31
Ether Extract	1.67	0.77	5.68	4.80	2.97	2.18	2.08	2.26	0.78	0.74	0.66	0.61
Crude Fiber	30.51	5.57	8.17	3.79	28.27	29.41	28.77	28.16	4.79	4.62	4.59	4.56
N-free Extract	38.09	16.23	33.38	53.83	40.85	38.07	41.78	44.02	8.19	8.19	7.26	11.51
Ash	7.66	1.75	5.62	3.88	8.33	8.99	8.33	8.31	2.60	2.56	2.41	2.24

TABLE XV.—(Continued)

	Urine					Milk			
	Cow 1	Cow 2	Cow 3	Cow 4		Cow 1	Cow 2	Cow 3	Cow 4
Water	91.47	92.15	92.08	92.80	Water	89.38	87.40	88.18	88.13
Dry Matter	8.53	7.85	7.92	7.20	Nitrogen	0.371	0.474	0.417	0.455
Nitrogen	0.605	0.547	0.567	0.466	Total Protein	2.36	2.97	2.66	2.77
Crude Protein	.....	.....	.....	.....	Fat	3.03	3.25	3.23	3.35
Ether Extract	.....	.....	.....	.....	Lactose	4.36	5.69	5.30	5.11
Crude Fiber	.....	.....	.....	.....	Ash	0.73	0.69	0.63	0.64
N-free Extract	.....	.....	.....	.....					
Ash	3.46	3.55	3.39	3.18					

TABLE XVI.
COMPOSITION OF INTAKE AND OUTGO SERIES II PERIOD IV

	Intake		Refuse				Feces				Urine			
	Hay	Silage	Cow 1	Cow 2	Cow 3	Cow 4	Cow 1	Cow 2	Cow 3	Cow 4	Cow 1	Cow 2	Cow 3	Cow 4
Water	10.44	72.94	8.90	18.58	3.82	6.18	86.72	86.45	87.12	87.52	92.18	92.28	92.59	93.97
Dry Matter	89.56	27.06	91.10	81.42	96.18	93.82	13.28	13.55	12.88	12.48	7.82	7.72	7.41	6.03
Nitrogen	1.246	0.414	1.42	1.162	1.373	1.289	0.218	0.225	0.214	0.198	0.514	0.465	0.451	0.458
Crude Protein	7.79	2.65	8.88	7.27	8.58	8.06	1.36	1.41	1.38	1.24	.....	.....	.....	.....
Ether Extract	1.30	0.77	1.20	1.21	1.29	1.30	0.17	0.19	0.19	0.17	.....	.....	.....	.....
Crude Fiber	30.09	5.57	29.29	28.30	30.84	30.09	4.08	4.11	3.83	4.00	.....	.....	.....	.....
N-free Extract	42.48	16.23	43.27	37.59	45.90	44.63	5.95	5.83	5.80	5.43	.....	.....	.....	.....
Ash	7.92	1.75	8.46	7.05	9.57	9.65	1.72	1.76	1.68	1.62	3.14	3.31	3.36	3.13

TABLE XVI.—(Continued)

	Milk			
	Cow 1	Cow 2	Cow 3	Cow 4
Water	89.18	88.12	88.70	88.50
Nitrogen	0.376	0.423	0.447	0.436
Total Protein	2.40	2.70	2.85	2.78
Fat	3.10	3.70	3.15	3.45
Lactose	4.63	4.78	4.67	4.59
Ash	0.69	0.70	0.63	0.68

TABLE XVII.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES II PERIOD I

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Hay	20.35	1.475	18.875	0.2177	1.355	0.3948	6.355	8.598	1.5608
		Silage	20.00	14.322	5.678	0.0788	0.490	0.1480	1.328	3.236	0.4760
		Water and Salt.	67.28	67.179	0.101	.....	.....	.....	.....	.....	0.0927
		Sub-total	107.63	82.976	24.654	0.2965	1.845	0.5428	7.683	11.834	2.1295
		Refuse	0.91	0.062	0.848	0.0113	0.071	0.0211	0.287	0.389	0.0800
		Total Intake	106.72	82.914	23.806	0.2852	1.774	0.5217	7.396	11.445	2.0495
	Outgo	Milk	25.84	23.198	2.643	0.1065	0.680	0.5814	.....	1.251	0.1977
		Urine	12.09	11.034	1.055	0.0748	.....	.....	.....	.....	0.4618
		Feces	54.43	44.263	10.168	0.1562	0.974	0.2395	3.092	4.365	1.4968
		Total Outgo	92.36	78.495	13.866	0.3375	1.654	0.8209	3.092	5.616	2.1563
		Balance	+14.36	+4.419	+9.940	−0.0523	.....	−0.2992	+4.304	+5.829	−0.1068
Cow 2	Intake	Hay	20.35	1.475	18.875	0.2177	1.355	0.3948	6.355	8.598	1.5608
		Silage	20.00	14.322	5.678	0.0788	0.490	0.1480	1.328	3.236	0.4760
		Water and Salt.	64.22	64.121	0.099	.....	.....	.....	.....	.....	0.0908
		Sub-total	104.57	79.918	24.652	0.2965	1.845	0.5428	7.683	11.834	2.1276
		Refuse	4.13	0.305	3.825	0.0513	0.321	0.1000	1.300	1.739	0.3651
		Total Intake	100.44	79.613	20.827	0.2452	1.524	0.4428	6.383	10.095	1.7625
	Outgo	Milk	17.33	15.250	2.080	0.0714	0.456	0.6239	.....	0.870	0.1300
		Urine	10.24	9.371	0.869	0.0676	.....	.....	.....	.....	0.3830
		Feces	52.54	44.433	8.107	0.1340	0.837	0.0263	2.391	3.462	1.2557
		Total Outgo	80.11	69.054	11.056	0.2730	1.293	0.6502	2.391	4.332	1.7687
		Balance	+20.33	+10.559	+9.771	−0.0278	.....	−0.2074	+3.992	+5.763	−0.0062

TABLE XVII.—(Continued)

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 3	Intake	Hay	20.35	1.475	18.875	0.2177	1.355	0.3948	6.355	8.598	1.5608
		Silage	20.00	14.322	5.678	0.0788	0.490	0.1480	1.328	3.236	0.4760
		Water and Salt.	61.04	60.943	0.097	.....	.....	.....	.....	.....	0.0887
		Sub-total	101.39	76.740	24.650	0.2965	1.845	0.5428	7.683	11.834	2.1255
		Refuse	6.42	0.506	5.914	0.0779	0.422	0.1605	1.961	2.809	0.5605
		Total Intake	94.97	76.234	18.736	0.2186	1.423	0.3823	5.722	9.025	1.5650
	Outgo	Milk	23.36	20.585	2.775	0.0939	0.600	0.5139	.....	1.502	0.1610
		Urine	9.61	8.808	0.802	0.0591	.....	.....	.....	.....	0.3652
		Feces	52.15	44.390	7.760	0.1272	0.793	0.1825	2.524	3.129	1.1317
		Total Outgo	85.12	73.783	11.337	0.2802	1.393	0.6964	2.524	4.631	1.6579
		Balance	+9.85	+2.451	+7.399	−0.0616	.....	−0.1841	+3.198	+4.394	−0.0929
Cow 4	Intake	Hay	20.35	1.475	18.875	0.2177	1.355	0.3948	6.355	8.598	1.5608
		Silage	20.00	14.322	5.678	0.0788	0.490	0.1480	1.328	3.236	0.4760
		Water and Salt.	67.42	67.319	0.101	.....	.....	.....	.....	.....	0.0978
		Sub-total	107.77	83.116	24.654	0.2965	1.845	0.5428	7.683	11.834	2.1346
		Refuse	0.000	0.000	0.000	0.0000	0.000	0.0000	0.000	0.000	0.0000
		Total Intake	107.77	83.116	24.654	0.2965	1.845	0.5428	7.683	11.834	2.1346
	Outgo	Milk	17.11	15.019	2.091	0.0734	0.469	0.4876	.....	1.008	0.1259
		Urine	15.57	14.513	1.057	0.0716	.....	.....	.....	.....	0.4484
		Feces	66.20	55.893	10.307	0.1576	0.986	0.2714	3.171	4.382	1.5027
		Total Outgo	98.88	85.425	13.455	0.3026	1.455	0.7590	3.171	5.390	2.0770
		Balance	+8.89	−2.309	+11.199	−0.0061	.....	−0.2162	+4.512	+6.444	−0.0402

TABLE XVIII.
DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES II PERIOD II

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Hay	20.00	1.570	18.430	0.2006	1.254	0.4500	6.258	9.008	1.4600
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Oil Meal	1.01	0.102	0.908	0.0598	0.374	0.0574	0.085	0.338	0.0568
		Water and Salt.	81.03	80.918	0.112	.....	.....	.....	.....	.....	0.1014
		Sub-total	122.04	97.178	24.862	0.3432	2.158	0.5614	4.457	12.592	1.9682
		Refuse	0.13	0.007	0.123	0.0014	0.008	0.0022	0.044	0.059	0.0094
		Total Intake	121.91	97.171	24.739	0.3418	2.150	0.6592	7.413	12.533	1.9588
	Outgo	Milk	24.37	21.704	2.566	0.0936	0.585	0.7701	.....	0.989	0.1901
		Urine	12.28	11.156	1.124	0.0752	.....	.....	.....	.....	0.4862
		Feces	61.54	50.875	10.665	0.1711	1.071	0.1292	3.163	4.757	1.5447
		Total Outgo	98.19	83.735	14.355	0.3399	1.656	0.8893	3.163	5.746	2.2211
		Balance	+23.72	+13.436	+10.384	+0.0019	.....	−0.2401	+4.250	+6.787	−0.2323
Cow 2	Intake	Hay	20.00	1.570	18.430	0.2006	1.254	0.4500	6.258	9.008	1.4600
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Oil Meal	0.52	0.053	0.467	0.0308	0.192	0.0295	0.043	0.174	0.0292
		Water and Salt.	79.12	79.010	0.110	.....	.....	.....	.....	.....	0.1002
		Sub-total	119.64	95.221	24.419	0.3142	1.976	0.6335	7.415	12.428	1.9394
		Refuse	0.11	0.007	0.103	0.0016	0.012	0.0020	0.039	0.042	0.0100
		Total Intake	119.53	95.214	24.316	0.3128	1.964	0.6315	7.376	12.386	1.9294
	Outgo	Milk	18.12	15.886	2.234	0.0886	0.564	0.6378	.....	0.902	0.1341
		Urine	11.17	10.209	0.961	0.0746	.....	.....	.....	.....	0.4222
		Feces	69.26	58.829	10.431	0.1496	0.935	0.1593	3.151	4.807	1.3783
		Total Outgo	98.55	84.924	13.266	0.3128	1.499	0.7971	3.151	5.709	1.9346
		Balance	+20.98	+10.290	+11.050	0.0000	.....	−0.1656	+4.225	+6.677	+0.0052

TABLE XVIII—(Continued)

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 3	Intake	Hay	20.00	1.570	18.430	0.2006	1.254	0.4500	6.258	9.008	1.4600
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Gluten Feed	1.60	0.136	1.464	0.0646	0.404	0.0768	0.061	0.861	0.0621
		Water and Salt.	67.96	67.858	0.102	.....	.....	.....	.....	.....	0.0931
		Sub-total	109.56	84.152	25.408	0.3480	2.188	0.6808	7.433	13.115	1.9652
		Refuse	2.24	0.125	2.115	0.0253	0.158	0.0419	0.752	0.987	0.1767
		Total Intake	107.32	84.027	23.293	0.3227	2.030	0.6389	6.881	12.128	1.7885
	Outgo	Milk	21.27	17.754	2.516	0.0940	0.600	0.6977	.....	1.066	0.1531
		Urine	11.18	10.295	0.886	0.0788	.....	.....	.....	.....	0.3868
		Feces	57.60	48.234	9.366	0.1559	0.975	0.1304	2.886	3.997	1.2304
		Total Outgo	90.05	76.283	12.768	0.3287	1.575	0.8281	2.886	5.063	1.7703
		Balance	+17.27	+7.744	+10.525	−0.0060	.....	−0.1892	+3.995	+7.065	+0.0182
Cow 4	Intake	Hay	20.00	1.570	18.430	0.2006	1.254	0.4500	6.258	9.008	1.4600
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Gluten Feed	0.15	0.013	0.137	0.0061	0.038	0.0072	0.006	0.081	0.0058
		Water and Salt.	73.73	73.624	0.106	.....	.....	.....	.....	.....	0.0968
		Sub-total	113.88	89.795	24.085	0.2895	1.822	0.6112	7.378	12.335	1.9126
		Refuse	1.18	0.071	1.109	0.0144	0.090	0.0203	0.384	0.520	0.0948
		Total Intake	112.70	89.724	22.976	0.2751	1.732	0.5909	6.994	11.815	1.8178
	Outgo	Milk	16.80	14.750	2.050	0.0719	0.459	0.5410	.....	0.937	0.1126
		Urine	13.49	12.440	1.050	0.0586	.....	.....	.....	.....	0.4573
		Feces	67.91	57.595	10.315	0.1535	0.958	0.2241	3.158	4.564	1.4125
		Total Outgo	98.20	84.785	13.415	0.2840	1.417	0.7651	3.158	5.501	1.9824
		Balance	+14.50	+4.939	+9.561	−0.0089	.....	−0.1742	+3.836	+6.314	−0.1646

TABLE XIX.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES II PERIOD III

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Hay	24.40	3.994	20.406	0.2228	1.391	0.4055	7.444	9.294	1.8690
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Gluten Feed	1.50	0.127	1.373	0.0606	0.378	0.0720	0.057	0.808	0.0582
		Water and Salt.	65.85	65.750	0.100	.....	.....	.....	.....	.....	0.0918
		Sub-total	111.75	84.459	27.291	0.3662	2.299	0.6315	8.615	13.348	2.3690
		Refuse	1.39	0.194	1.196	0.0126	0.078	0.0413	0.393	0.568	0.1158
		Total Intake	110.36	84.265	26.095	0.3536	2.221	0.5902	8.222	12.780	2.2532
	Outgo	Milk	21.55	19.261	2.289	0.0799	0.509	0.6530	.....	0.940	0.1573
		Urine	10.55	9.650	0.900	0.0638	.....	.....	.....	.....	0.3640
		Feces	67.43	55.515	11.915	0.1639	1.025	0.5260	3.239	5.523	1.7532
		Total Outgo	99.53	84.426	15.104	0.3076	1.534	1.1790	3.239	6.463	2.2745
		Balance	+10.83	−0.161	+10.991	+0.0460	.....	−0.5888	+4.983	+6.317	−0.0213
Cow 2	Intake	Hay	19.70	3.225	16.475	0.1799	1.123	0.3290	5.828	7.504	1.4090
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Gluten Feed	0.80	0.068	0.732	0.0320	0.202	0.0384	0.030	0.431	0.0310
		Water and Salt.	45.65	45.565	0.085	.....	.....	.....	.....	.....	0.0790
		Sub-total	86.15	63.446	22.704	0.2947	1.855	0.5214	6.972	11.181	1.8690
		Refuse	2.47	0.375	2.095	0.0244	0.153	0.0539	0.726	0.940	0.2221
		Total Intake	83.68	63.071	20.609	0.2703	1.702	0.4675	6.246	10.241	1.6469
	Outgo	Milk	14.03	12.262	1.768	0.0662	0.417	0.4560	.....	0.798	0.0968
		Urine	11.51	10.606	0.904	0.0630	.....	.....	.....	.....	0.4086
		Feces	51.61	42.490	9.120	0.1285	0.805	0.3819	2.384	4.227	1.3212
		Total Outgo	77.15	65.358	11.792	0.2577	1.222	0.8379	2.384	5.025	1.8266
		Balance	+6.53	−2.287	+8.817	+0.0126	.....	−0.3694	+3.862	+5.216	−0.1797

TABLE XIX—(Continued)

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 3	Intake	Hay	20.50	3.356	17.144	0.3372	2.119	0.5627	7.487	11.502	2.0782
		Silage	20.50	14.953	5.547	0.0849	0.543	0.1578	1.142	3.327	0.3588
		Oil Meal	1.10	0.112	0.988	0.0651	0.407	0.0625	0.090	0.367	0.0618
		Water and Salt	58.75	58.655	0.095	.....	.....	.....	.....	.....	0.0873
		Sub-total	100.85	77.076	23.774	0.3372	2.119	0.5627	7.487	11.502	2.0782
		Refuse	0.81	0.101	0.709	0.0085	0.053	0.0169	0.233	0.338	0.0675
		Total Intake	100.04	76.975	23.065	0.3287	2.066	0.5458	7.254	11.164	2.0107
	Outgo	Milk	20.02	17.654	2.366	0.0835	0.533	0.6466	.....	1.061	0.1261
		Urine	9.42	8.674	0.746	0.0534	.....	.....	.....	.....	0.3193
		Feces	60.46	50.557	9.903	0.1415	0.883	0.4051	2.775	4.389	1.4571
		Total Outgo	89.90	76.885	13.015	0.2784	1.416	1.0517	2.775	5.450	1.9025
		Balance	+10.14	+0.090	+10.050	+0.0503	.....	−0.5059	+4.479	+5.714	+0.1082
Cow 4	Intake	Hay	21.25	3.479	17.771	0.1940	1.211	0.3549	6.483	8.094	1.6278
		Silage	20.00	14.588	5.412	0.0828	0.530	0.1540	1.114	3.246	0.3500
		Oil Meal	0.15	0.015	0.135	0.0089	0.056	0.0085	0.012	0.050	0.0084
		Water and Salt	62.75	62.652	0.098	.....	.....	.....	.....	.....	0.0898
		Sub-total	104.15	80.734	23.416	0.2857	1.797	0.5174	7.609	11.390	2.0760
		Refuse	1.77	0.206	1.564	0.0160	0.100	0.0400	0.498	0.779	0.1471
		Total Intake	102.38	80.528	21.852	0.2697	1.697	0.4774	7.111	10.611	1.9289
	Outgo	Milk	14.58	12.849	1.731	0.0663	0.404	0.4884	.....	0.745	0.0933
		Urine	12.06	11.192	0.868	0.0562	.....	.....	.....	.....	0.3835
		Feces	71.44	57.159	14.281	0.1436	0.936	0.4358	3.258	8.223	1.6003
		Total Outgo	98.08	81.200	16.880	0.2661	1.340	0.9242	3.258	8.968	2.0771
		Balance	+4.30	−0.672	+4.972	+0.0036	.....	−0.4378	+3.853	+1.643	−0.1482

TABLE XX.

DAILY BALANCE OF FOOD NUTRIENTS IN POUNDS SERIES II PERIOD IV

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 1	Intake	Hay	23.20	2.422	20.778	0.2891	1.807	0.3016	6.981	9.855	1.8354
		Silage	20.00	14.588	5.412	0.0828	0.531	0.1540	1.114	3.242	0.3500
		Water and Salt.	84.65	84.536	0.114	.....	.....	.....	.....	.....	0.1037
		Sub-total	127.85	101.546	26.304	0.3719	2.338	0.4556	8.095	13.097	2.2891
		Refuse	3.30	0.294	3.006	0.0469	0.293	0.0396	0.967	1.428	0.2792
		Total Intake	124.55	101.252	23.298	0.3250	2.045	0.4160	7.128	11.669	2.0099
	Outgo	Milk	16.52	14.732	1.788	0.0621	0.397	0.5121	.....	0.765	0.1140
		Urine	12.38	11.412	0.968	0.0636	.....	.....	.....	.....	0.3887
		Feces	77.74	67.416	10.324	0.1695	1.057	0.1322	3.172	4.626	1.3371
		Total Outgo	106.64	93.560	13.080	0.2952	1.454	0.6443	3.172	5.391	1.8398
		Balance	+17.91	+7.692	+10.218	+0.0298	.....	−0.2283	+3.956	+6.278	+0.1701
Cow 2	Intake	Hay	23.20	2.422	20.778	0.2891	1.807	0.3016	6.981	9.855	1.8354
		Silage	20.00	14.588	5.412	0.0828	0.531	0.1540	1.114	3.242	0.3500
		Walter and Salt.	80.45	80.339	0.111	.....	.....	.....	.....	.....	0.1011
		Sub-total	123.65	97.349	26.301	0.3719	2.338	0.4556	8.095	13.097	2.2865
		Refuse	4.20	0.780	3.420	0.0488	0.305	0.0508	1.189	1.579	0.2981
		Total Intake	119.45	96.569	22.881	0.3231	2.033	0.4048	6.906	11.518	1.9884
	Outgo	Milk	13.52	11.914	1.606	0.0552	0.365	0.5002	.....	0.646	0.0944
		Urine	12.20	11.258	0.942	0.0567	.....	.....	.....	.....	0.40 8
		Feces	70.92	61.331	9.589	0.1596	1.000	0.1347	2.915	4.135	1.0482
		Total Outgo	96.64	84.503	12.137	0.2715	1.365	0.6349	2.915	4.781	1.5464
		Balance	+22.81	+12.066	+10.744	+0.0516	.....	−0.2301	+3.991	+6.737	+0.4420

TABLE XX.—(Continued)

			Total Amounts	Water	Dry Matter	Total Nitrogen	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ash
Cow 3	Intake	Hay	23.20	2.422	20.778	0.2891	1.807	0.3016	6.981	9.855	1.8354
		Silage	20.00	14.588	5.412	0.0828	0.531	0.1540	1.114	3.242	0.3500
		Water and Salt.	69.05	68.947	0.103	.....	.....	.....	.....	.....	0.0938
		Sub-total	112.25	85.957	26.293	0.3719	2.338	0.4556	8.095	13.097	2.2792
		Refuse	7.60	0.290	7.310	0.1043	0.652	0.0980	2.344	3.488	0.7373
		Total Intake	104.65	85.667	18.983	0.2676	1.686	0.3576	5.751	9.609	1.5419
	Outgo	Milk	15.64	13.873	1.767	0.0699	0.446	0.4927	.....	0.730	0.0985
		Urine	11.62	10.759	0.861	0.0524	.....	.....	.....	.....	0.3904
		Feces	67.66	58.945	8.715	0.1448	0.934	0.1286	2.591	3.923	1.1367
		Total Outgo	94.92	83.577	11.343	0.2671	1.380	0.6213	2.591	4.653	1.6256
		Balance	+9.73	+2.090	+7.640	+0.0005	.....	−0.2637	+3.160	+4.956	−0.0837
Cow 4	Intake	Hay	23.20	2.422	20.778	0.2891	1.807	0.3016	6.981	9.855	1.8354
		Silage	20.00	14.588	5.412	0.0828	0.531	0.1540	1.114	3.242	0.3500
		Water and Salt.	82.15	82.038	0.112	.....	.....	.....	.....	.....	0.1021
		Sub-total	125.35	99.048	26.302	0.3719	2.338	0.4556	8.095	13.097	2.2875
		Refuse	4.74	0.293	4.447	0.0611	0.382	0.0616	1.426	2.116	0.4574
		Total Intake	120.61	98.755	21.855	0.3108	1.956	0.3940	6.669	10.981	1.8301
	Outgo	Milk	12.70	11.239	1.461	0.0554	0.353	0.4382	.....	0.583	0.0864
		Urine	13.52	12.705	0.815	0.0619	.....	.....	.....	.....	0.4232
		Feces	78.06	68.318	9.742	0.1546	0.968	0.1327	3.122	4.239	1.2646
		Total Outgo	104.28	92.262	12.018	0.2714	1.321	0.5709	3.122	4.822	1.7742
		Balance	+16.33	+6.493	+9.837	+0.0394	.....	−0.1769	+3.547	+6.159	+0.0559

TABLE XXI.
AVAILABILITY OF NITROGEN FOR MAINTENANCE

		Series I						Series II				
		Basal Ration Per. I	Oil Meal Per. II	Oil Meal Per. III	Oil Meal Per. IV	Gluten Feed Per. V	Gluten Feed Per. VI	Basal Ration Per. I	Oil Meal Per. II	Gluten Feed Per. II	Gluten Feed Per. III	Oil Meal Per. III
Cow 1	Nitrogen Digested ...	0.0747	0.3243	0.4176	0.4290	0.3135	0.2524	0.1290	0.1707	.....	0.1893	.....
	Nitrogen in Milk	0.1004	0.1192	0.1322	0.1191	0.1055	0.0990	0.1065	0.0936	.....	0.0799	.....
	Maximum N Available for Maintenance ..	−0.0257	0.2051	0.2854	0.3099	0.2080	0.1534	0.0225	0.0771	.....	0.1094	.....
	Nitrogen Balance	−0.1123	−0.0236	+0.0424	+0.0104	+0.0518	+0.0258	−0.0523	+0.0019	.....	+0.0460	.....
	% Availability of N Digested	.....	38.4	49.7	36.6	70.2	77.1	.....	99.3	.....	113.1	.....
Cow 2	Nitrogen Digested ...	0.0972	0.2923	0.3610	0.4470	0.3052	0.2671	0.1112	0.1632	.....	0.1418	.....
	Nitrogen in Milk	0.1023	0.1080	0.1202	0.1106	0.1093	0.0944	0.0714	0.0886	.....	0.0662	.....
	Maximum N Available for Maintenance ..	−0.0051	0.1843	0.2408	0.3354	0.1959	0.1727	0.0398	0.0746	.....	0.0756	.....
	Nitrogen Balance	−0.0861	−0.0221	+0.0279	+0.0611	+0.0378	+0.0375	−0.0278	0.0000	.....	+0.0126	.....
	% Availability of N Digested	.....	33.8	46.0	43.1	61.6	69.5	.....	79.9	.....	112.8	.....
Cow 3	Nitrogen Digested ...	0.0936	0.2650	0.3237	0.3993	0.3360	0.2249	0.0914	.....	0.1668	.....	0.1872
	Nitrogen in Milk	0.0911	0.1134	0.1251	0.1277	0.1113	0.0941	0.0939	.....	0.0940	.....	0.0835
	Maximum N Available for Maintenance ..	0.0025	0.1516	0.1986	0.2716	0.2247	0.1308	0.0025	.....	0.0728	.....	0.1037
	Nitrogen Balance	−0.0779	−0.0279	+0.0097	−0.0006	+0.0175	+0.0075	−0.0616	.....	−0.0060	.....	+0.0503
	% Availability of N Digested	.....	33.5	34.8	28.7	42.9	66.6	.....	.....	73.8	.....	105.4

Note: Availability could not be calculated for Cow 4, Series II, because in the basal period she shows more digested nitrogen than in any other period. (Nitrogen digested is expressed as the difference between total nitrogen intake and nitrogen in feces.)

TABLE XXII.

AVAILABILITY OF NITROGEN FOR MAINTENANCE AND MILK PRODUCTION

		Series I						Series II				
		Basal Ration Per. I	Oil Meal Per. II	Oil Meal Per. III	Oil Meal Per. IV	Gluten Feed Per. V	Gluten Feed Per. VI	Basal Ration Per. I	Oil Meal Per. II	Gluten Feed Per II	Gluten Feed Per. III	Oil Meal Per. III
Cow 1	Nitrogen Digested ...	0.0747	0.3243	0.4176	0.4290	0.3135	0.2524	0.1290	0.1707	.....	0.1893	.....
	Nitrogen in Milk	0.1004	0.1192	0.1322	0.1191	0.1055	0.0990	0.1065	0.0936	.....	0.0799	.....
	Nitrogen Balance	−0.1123	−0.0236	+0.0424	+0.0104	+0.0518	+0.0258	−0.0523	+0.0019	.....	+0.0460	.....
	% Availability of N Digested	.....	43.1	53.2	39.9	70.9	76.9	.....	99.0	.....	118.9	.....
Cow 2	Nitrogen Digested ...	0.0972	0.2923	0.3610	0.4470	0.3052	0.2671	0.1112	0.1632	.....	0.1418	.....
	Nitrogen in Milk	0.1023	0.1080	0.1202	0.1106	0.1093	0.0944	0.0714	0.0886	.....	0.0662	.....
	Nitrogen Balance	−0.0861	−0.0221	+0.0279	+0.0611	+0.0378	+0.0375	−0.0278	0.0000	.....	+0.0126	.....
	% Availability of N Digested	.....	35.7	49.6	44.5	62.9	77.4	.....	86.5	.....	115.0	.....
Cow 3	Nitrogen Digested ...	0.0936	0.2650	0.3237	0.3993	0.3360	0.2249	0.0914	.....	0.1668	.....	0.1872
	Nitrogen in Milk	0.0911	0.1134	0.1251	0.1277	0.1113	0.0941	0.0939	.....	0.0940	.....	0.0835
	Nitrogen Balance	−0.0779	−0.0279	+0.0097	−0.0006	+0.0175	+0.0075	−0.0616	.....	−0.0060	.....	+0.0503
	% Availability of N Digested	.....	42.7	52.8	37.3	47.7	67.3	.....	.....	73.9	.....	105.9

Note: Availability could not be calculated for Cow 4, Series II, because in the basal period she shows more digested nitrogen than in any other period. (Nitrogen digested is expressed as the difference between total nitrogen intake and nitrogen in feces.)

TABLE XXIII.
GAIN OR LOSS IN POUNDS BY PERIODS

		Series I						Series II		
		Per. I	Per. II	Per. III	Per. IV	Per. V	Per. VI	Per. I	Per. II	Per. III
Cow 1	Weight at Beginning	1153	1113	.....	1135	1076	1114	1043	1014	1032
	Weight at End	1120	1115	.....	1090	1069	1131	1005	1022	1024
	Gain or Loss	−33	+2	.....	−45	−7	+17	−38	+8	−8
Cow 2	Weight at Beginning	1378	1306	.....	1311	1246	1306	830	893	842
	Weight at End	1315	1298	.....	1276	1284	1312	805	884	838
	Gain or Loss	−63	−8	.....	−35	+38	+6	−25	−9	−4
Cow 3	Weight at Beginning	1040	1013	.....	1057	1007	1035	936	920	928
	Weight at End	1014	1042	.....	1002	1033	1030	890	891	891
	Gain or Loss	−26	+29	.....	−55	+26	−5	−46	−29	−37
Cow 4	Weight at Beginning	.....	.....	.....	.....	.....	.....	864	904	894
	Weight at End	.....	.....	.....	.....	.....	.....	829	889	882
	Gain or Loss	.....	.....	.....	.....	.....	.....	−35	−15	−16

TABLE XXIV.
SUPPLY AND REQUIREMENTS OF ENERGY IN THERMS

			Series I						Series II				
			Basal Ration Per. I	Oil Meal Per. II	Oil Meal Per. III	Oil Meal Per. IV	Gluten Feed Per. V	Gluten Feed Per. VI	Basal Ration Per. I	Oil Meal Per. II	Gluten Feed Per II	Gluten Feed Per. III	Oil Meal Per. III
Cow 1	A	Hay	3.89	4.04	5.10	4.38	4.79	5.49	6.52	6.67	.....	7.72	.....
		Silage	4.97	4.97	4.97	4.97	4.97	4.97	3.31	3.31	.....	3.31	.....
		Concentrate	.....	3.95	4.74	4.95	4.76	3.18	.....	0.80	.....	1.19	.....
		Total Intake	8.86	12.96	14.81	14.30	14.52	13.64	9.83	10.78	.....	12.22	.....
	B	For Maintenance	6.54	6.46	6.45	6.45	6.29	6.49	6.10	6.03	.....	6.11	.....
		For Milk	6.74	6.83	7.88	7.59	5.62	4.98	4.36	5.78	.....	4.90	.....
		Tot. Requirements	13.28	13.29	14.33	14.04	11.91	11.47	10.46	11.81	.....	11.01	.....
		Balance	−4.42	−0.33	+0.48	+0.26	+2.61	+2.17	−0.63	−1.03	.....	+1.21	.....
Cow 2	A	Hay	4.43	5.09	5.45	5.59	4.80	5.47	5.44	6.68	.....	5.78	.....
		Silage	4.97	4.97	4.97	4.97	4.97	4.97	3.31	3.31	.....	3.31	.....
		Concentrate	.....	3.16	3.95	4.58	4.76	3.57	.....	0.41	.....	0.63	.....
		Total Intake	9.40	13.22	14.37	15.14	14.53	14.01	8.75	10.40	.....	9.72	.....
	B	For Maintenance	7.35	7.19	7.17	7.15	7.05	7.21	5.23	5.53	.....	5.33	.....
		For Milk	6.63	6.67	7.13	6.45	5.75	5.24	4.68	4.78	.....	3.42	.....
		Tot. Requirements	13.98	13.86	14.30	13.60	12.80	12.45	9.91	10.31	.....	8.75	.....
		Balance	−4.58	−0.64	+0.07	+1.54	+1.73	+1.56	−1.16	+0.09	.....	+0.97	.....
Cow 3	A	Hay	4.63	5.11	5.31	4.80	5.01	5.56	4.67	.....	5.96	.....	6.61
		Silage	4.97	4.97	4.97	4.97	4.97	4.97	3.31	.....	3.31	.....	3.39
		Concentrate	.....	2.76	3.55	4.74	4.76	2.86	.....	.....	1.27	.....	0.87
		Total Intake	9.60	12.84	13.83	14.51	14.74	13.39	7.98	.....	10.54	.....	10.87
	B	For Maintenance	6.11	6.11	6.11	6.12	6.08	6.13	5.63	.....	5.60	.....	5.61
		For Milk	5.69	6.77	7.35	7.22	5.98	5.59	3.85	.....	5.23	.....	4.85
		Tot. Requirements	11.80	12.88	13.46	13.34	12.07	11.72	9.48	.....	10.83	.....	10.46
		Balance	−2.20	−0.04	+0.37	+1.17	+2.67	+1.67	−1.50	.....	−0.29	.....	+0.41

A—Therms Supplied. B—Therms Required.

TABLE XXV.
AVAILABILITY OF NITROGEN AS COMPARED WITH THERMS IN HAY AND SILAGE

		Series I						Series II				
		Basal Ration Per. I	Oil Meal Per. II	Oil Meal Per. III	Oil Meal Per. IV	Gluten Feed Per. V	Gluten Feed Per. VI	Basal Ration Per. I	Oil Meal Per. II	Gluten Feed Per. II	Gluten Feed Per. III	Oil Meal Per. III
Cow 1	Total Therms Required	13.28	13.29	14.33	14.04	11.91	11.47	10.46	11.81	.....	11.01	.....
	Therms in Hay and Silage	8.86	9.01	10.07	9.35	9.76	10.46	9.83	9.98	.....	11.03	.....
	% Required Therms in Hay and Silage	66.7	67.8	70.3	66.6	81.9	91.2	94.0	84.5	.....	100.2	.....
	% Availability Nitrogen (Table XXI)	.....	38.4	49.7	36.6	70.2	77.1	.....	99.3	.....	113.1	.....
	% Availability Nitrogen (Table XXII)	.....	43.1	53.2	39.9	70.9	76.9	.....	99.0	.....	118.9	.....
Cow 2	Total Therms Required	13.98	13.86	14.30	13.60	12.80	12.45	9.91	10.31	.....	8.75	.....
	Therms in Hay and Silage	9.40	10.06	10.42	10.56	9.77	10.44	8.75	9.99	.....	9.09	.....
	% Required Therms in Hay and Silage	67.2	72.6	72.9	77.6	76.3	83.9	88.3	96.9	.....	103.8	.....
	% Availability Nitrogen (Table XXI)	.....	33.8	46.0	43.1	61.6	69.5	.....	79.9	.....	112.8	.....
	% Availability Nitrogen (Table XXII)	.....	35.7	49.6	44.5	62.9	77.4	.....	86.5	.....	115.0	.....
Cow 3	Total Therms Required	11.80	12.88	13.46	13.34	12.07	11.72	9.48	.....	10.83	.....	10.46
	Therms in Hay and Silage	9.60	10.08	10.28	9.77	9.98	10.53	7.98	.....	9.27	.....	10.00
	% Required Therms in Hay and Silage	81.4	79.0	76.3	73.2	82.7	89.0	84.4	.....	85.6	.....	95.6
	% Availability Nitrogen (Table XXI)	.....	33.5	34.8	28.7	42.9	66.6	.....	.....	73.8	.....	105.4
	% Availability Nitrogen (Table XXII)	.....	42.7	52.8	37.3	47.7	67.3	.....	.....	73.9	.....	105.9

CONTENTS