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INVESTIGATIONS
IN
MILK-PRODUCTION

BY

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DAIRY AND ANIMAL HUSBANDMAN



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INVESTIGATIONS IN MILK-PRODUCTION

T. L. HAECKER

NUTRIENT REQUIREMENTS

Since the publication of Bulletin 79 of this Station on the nutrient requirements of cows for milk-production, additional experiments have been carried on with the dairy herd. More definite data have been secured on the minimum amount of protein and other nutrients that may be prescribed in a feeding standard. Such data aid in adjusting the ration to the need of cows giving milk of any quality or quantity. Other factors considered are maintenance of body weight, the ordinary variations in composition of feeds, proper nourishment of fetal growth, and the gradual development of the lacteal functions.

In a study of the disposition that the animal body makes of the different nutrients and the amount of each that it needs to do a certain amount of work without waste, it is necessary that a system of light feeding be carried on for a considerable period and with a large number of animals, because when there is more nourishment provided than a cow needs, all will not be utilized for milk-production. With some individuals and under certain conditions the excess will pass off in the excrement, and in some it will be converted into body fat. To avoid this as much as possible, light feeding has been the general rule. Because of this, and the fact that the cows under experiment were also used daily in class work for the study of breeds and of the relation of type and conformation to production, the yield of dairy products has not been as large as it would have been with heavier feeding and less disturbance. The cows were also all subjected to a regular routine of feeding and milking regardless of quantity and quality of milk yielded, and the grain mixture was the same for all members of the herd or group, having been adjusted to a daily average yield of 25 pounds of milk testing 4 per cent butter fat. Had we practiced feeding and milking large yielders three times a day and adjusted the grain ration to the needs of each individual, doubtless larger yields would have been secured.

On the other hand, the strict regularity as to the quantity of feed given and the uniformity in grade and quality of the feed, not only from day to day but from year to year, made the ration more efficient than would have been the case where both quantity and quality of feed given varied greatly.

During the years covered by this report, the hay fed was always

graded choice upland prairie, the silage was from dent corn, Minnesota No. 13, planted in drills, approximately 35 pounds of seed to the acre. The corn fed was No. 3 yellow, the oats No. 3 white, barley of good feeding grade, bran and oil meal fresh from the Minneapolis mills, and gluten meal and gluten feed from the Chicago glucose factory. The roots were mangels, grown on University Farm. The feed was therefore of better grade than would ordinarily be the case even in well-regulated dairies.

The cows were kept in the barn from fall, when stall feeding began, until time to turn to pasture in the spring. They were out of their stalls only when used in class work and about half an hour a day in a covered runway where they had access to water.

THE WINTER OF 1902-1903

During the winter of 1902-1903 the cows were divided into two groups. Group I received a grain mixture composed of 3 parts each of ground corn, barley, and oats, and 1 part oil meal, while Group II received a grain mixture composed of 3 parts each of ground corn, barley, and gluten meal, and 1 part of oil meal, except that Lou II in Group I and Betty C, Klondike, Nora, Pride III, and Rose C in Group II, to December 22, received a grain mixture composed of 2 parts each of corn, bran, and middlings, and 1 part each of oats and oil meal. The data from these cows are included in the tables because the nutrient content did not differ materially from the standard ration for Group II. The roughage fed was prairie hay and corn silage, and roots until December 8.

The amount of grain fed was adjusted to the apparent needs of each cow and as much hay and silage was fed as they would eat up clean. Because of the short time covered by the experiment and the changes in the grain mixtures, tables of summaries only will be given.

TABLE 1
AVERAGE AMOUNT OF FEED CONSUMED PER DAY, DRY MATTER, DAYS IN TRIAL,
AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Roots	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Group I							
L'Etoile.....	7.9	6.2	35.4	1.7	19.58	84	858
Lou II.....	10.1	6.8	45.0	6.2	24.13	112	919
Rose L.....	7.0	6.9	39.4	5.0	20.38	112	997
Shorty.....	5.7	6.1	23.4	5.9	15.58	112	742
Topsy II.....	8.5	7.1	38.7	1.7	21.51	84	867
Tricksey C.....	7.8	6.9	38.5	1.7	20.61	84	887
Trust.....	8.0	6.0	35.6	...	19.16	56	778
Trusty Lee.....	5.4	6.7	28.3	5.3	16.63	105	696
White.....	7.6	7.2	39.2	6.0	21.17	112	928
Average.....	7.5	6.6	35.9	3.7	19.86	96	852

TABLE 1—Continued

Cow	Grain	Hay	Silage	Roots	Dry Matter	Length of Trial	Live Weight
Group II	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Betty C.....	7.0	6.6	33.7	4.4	18.91	112	765
Cylene.....	6.9	6.8	33.2	5.3	18.96	112	802
Dora F.....	11.4	9.2	52.3	...	28.31	77	1,292
Duchess P. P.....	7.7	8.3	40.2	6.2	22.29	112	856
Fay.....	7.9	8.0	40.2	6.2	22.39	112	853
Houston II.....	7.4	6.9	36.0	6.2	20.21	112	836
Klondike.....	9.6	7.0	42.4	6.2	23.38	112	1,013
Nora.....	7.6	7.3	36.4	6.0	20.73	112	754
Pride III.....	7.7	6.9	39.5	...	20.56	70	809
Rose C.....	8.2	7.4	39.1	6.2	21.93	112	821
Average.....	8.1	7.4	39.3	4.7	21.77	104	880

TABLE 2

AVERAGE DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	DIGESTIBLE NUTRIENTS IN FEED			MILK	FAT		SOLIDS-NOT-FAT
	Crude Protein	Carbo-hydrates	Ether Extract		P. ct.	Lbs.	
	Lbs.	Lbs.	Lbs.	Lbs.			Lbs.
Group I							
L'Etoile.....	1.26	11.13	0.46	22.85	4.08	0.932	1.98
Lou II.....	1.79	13.07	.62	34.14	2.76	.942	2.74
Rose L.....	1.23	11.51	.45	15.86	4.66	.741	1.48
Shorty.....	0.96	8.81	.35	15.69	4.27	.671	1.38
Topsy II.....	1.38	12.19	.50	27.47	3.56	.977	2.40
Tricksey C.....	1.30	11.64	.47	29.04	4.15	1.204	2.50
Trust.....	1.28	10.81	.45	32.33	3.85	1.245	2.82
Trusty L.....	1.00	9.30	.37	18.17	4.31	.783	1.63
White.....	1.29	12.00	.47	18.63	4.73	.882	1.65
Average.....	1.28	11.16	.46	23.8	3.91	.931	2.06
Group II							
Betty C.....	1.62	10.01	.45	14.7	4.84	.711	1.36
Cylene.....	1.70	10.48	.39	22.1	3.10	.685	1.81
Dora F.....	2.69	15.63	.61	42.6	2.98	1.268	3.45
Duchess P. P.....	1.66	12.55	.48	19.6	5.31	1.044	1.79
Fay.....	1.99	12.41	.46	33.9	3.57	1.212	2.81
Houston II.....	1.84	11.20	.42	24.4	5.10	1.242	2.28
Klondike.....	2.12	12.44	.57	19.7	5.18	1.020	1.75
Nora.....	1.77	10.94	.49	21.0	4.79	1.006	1.96
Pride III.....	1.91	11.29	.44	28.5	4.56	1.300	2.62
Rose C.....	1.92	11.69	.51	25.8	3.93	1.015	2.32
Average.....	1.92	11.86	.48	25.2	4.16	1.05	2.21

By comparing the daily average nutrients consumed with the dairy products yielded, it is seen that the cows in Group I daily received 1.28 pounds of protein, 11.16 pounds of carbohydrates, and 0.46 pound of fat and returned 23.8 pounds of milk containing 0.931 pound of butter fat and 2.06 pounds of solids-not-fat, while Group II received 1.92

pounds of protein, 11.86 pounds of carbohydrates, and 0.48 pound of fat, and returned 25.2 pounds of milk, 1.05 pounds of butter fat, and 2.21 pounds of solids-not-fat.

More definite comparison can be made as to the efficiency of the two rations by reducing the nutrients in the feed and the milk solids produced, to their carbohydrate equivalent. Digestible ether extract in feed has approximately 2.2 times as great energy value as the other nutrients, and butter fat has about 2.25 times the energy value of the other organic solids in milk per pound.¹ Multiplying the ether extract in the feed by the proper coefficient and adding the product to the protein and carbohydrates, gives the nutriment in the feed consumed, and multiplying the butter fat by 2.25 and adding the product to the milk solids-not-fat gives the total nutriment in the dairy product yielded.

There is another factor that must be taken into account. Animals use a portion of the nutrients in feed for maintaining body heat and producing energy for carrying on the involuntary activities of the body and replacing body wear and waste.

The amount of nutriment required daily for maintenance of the body depends largely upon the size of the body, disposition, temperature of surrounding air, and similar considerations. The factors employed for computing the nutrients required daily for maintenance under average conditions in a dairy are 0.07 pound of protein, 0.7 pound of carbohydrates, and 0.01 pound of ether extract per 100 pounds of live weight or 0.792 pound of nutriment daily per hundred weight.

For example, the cow L'Etoile in Group I whose average weight during the winter was 858 pounds, received daily 1.26 pounds of digestible protein, 11.13 pounds of digestible carbohydrates, and 0.46 pound of digestible ether extract. Multiplying, $0.46 \times 2.2 = 1.012$, and adding the protein and carbohydrates, the sum, 13.40 pounds, represents the total nutriment daily.

Her live weight was 858 pounds. This weight multiplied by 0.00792 gives 6.79 pounds, the nutriment needed daily for maintenance. Subtracting this result from 13.40 pounds gives the remainder, 6.61 pounds as the nutriment left for product. The product is 0.932 pounds of butter and 1.98 pounds of organic solids-not-fat. Multiplying the 0.932 by 2.25 and adding 1.98, the solids-not-fat, the sum is 4.08 pounds, the total product yielded daily.

Similar computations made from the record of each cow and the average for the group gives the table following:

¹ This statement is not exact because the ether extract in feed varies. That in such feed as oil meal is nearly pure fat while that in roughage and especially in silage contains some other substances having a lower energy value. The ether extract in milk is pure fat and has a trifle greater energy value than the ether extract in a ration. The protein in feed and milk has a higher energy value per pound than the carbohydrates while the sugar in milk has a trifle lower value than the protein.

TABLE 3

AVERAGE NUTRIMENT, NUTRIMENT FOR MAINTENANCE AND PRODUCT, PRODUCT YIELDED PER DAY, AND NUTRIMENT PER POUND OF PRODUCT

Cow	NUTRIMENT DAILY	NUTRIMENT FOR		PRODUCT YIELDED DAILY	NUTRIMENT PER LB. OF PRODUCT	WEIGHT	
		Maintenance	Product			Period I	Period II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Group I							
L'Etoile	13.40	6.79	6.61	4.08	1.62	881	839
Lou II	16.22	7.28	8.94	4.86	1.84	931	907
Rose L	13.74	7.90	5.84	3.15	1.85	995	999
Shorty	10.53	5.88	4.65	2.89	1.61	759	725
Topsy II	14.68	6.87	7.81	4.60	1.70	876	858
Tricksey C	13.98	7.02	6.95	5.21	1.33	908	867
Trust	13.09	6.16	6.93	5.62	1.23	803	753
Trusty L	11.11	5.51	5.60	3.39	1.65	717	672
White	14.33	7.35	6.98	3.63	1.92	943	914
Average	13.45	6.75	6.70	4.15	1.61	868	837
Group II							
Betty C	12.62	6.06	6.56	2.96	2.22	754	776
Cylene	13.04	6.35	6.69	3.35	2.00	795	809
Dora F	19.66	10.18	9.48	6.30	1.50	1,287	1,296
Duchess P. P	15.27	6.78	8.49	4.14	2.05	860	851
Fay	15.41	6.76	8.65	5.54	1.56	866	840
Houston II	13.96	6.62	7.34	5.07	1.45	846	830
Klondike	15.81	8.02	7.79	4.04	1.93	1,013	1,012
Nora	13.78	5.97	7.81	4.22	1.85	756	753
Pride III	14.17	6.41	7.76	5.54	1.40	823	794
Rose C	14.73	6.50	8.23	4.60	1.79	822	820
Average	14.84	6.96	7.88	4.57	1.72	882	878

From Table 3 it appears that the cows of Group I, with a ration containing 1.28 pounds of crude protein daily, consumed daily 13.45 pounds of nutriment, that the amount calculated for daily maintenance was 6.75 pounds, that 6.70 pounds were available for milk-production, that the daily average production of milk solids was 4.15 pounds, and that 1 pound of milk solids or product was obtained to 1.61 pounds of nutriment. If it required 1.61 units of nutriment to produce 1 unit of product, there was an expenditure of 0.61 of a unit of nutriment in the energy required in mastication, digestion, assimilation, and transference of food nutriment to milk solids.

In the last two columns is given, under Period I, the average weight of each cow during the first half of the experiment and under Period II the average weight during the last half of the experiment. By the weights given it is shown that all the cows, save one, lost in body weight; that is, utilized a portion of the substances of the body for production, because of a shortage of nutriment or some nutrient in the feed. This is clearly shown from the fact that the greater the loss in body weight, the less nutriment was used for the production of

a pound of milk solids. The average weight of the group during the second period was 31 pounds less than during the first period.

From the same table it appears that the cows of Group II receiving 1.92 pounds of crude protein apiece daily consumed 14.85 pounds of nutriment, that the amount calculated for daily maintenance was 6.96 pounds, that 7.89 pounds were available for milk-production, that the daily average production of milk solids was 4.57 pounds, and that 1 pound of milk solids was obtained to 1.72 pounds of net nutriment. That is, out of 1.72 units of nutriment 1 pound was found in the milk and 0.72 pound was expended in the processes of production. The fact that the daily yield of dairy product was 4.57 pounds while the cows of Group I yielded only 4.15 pounds and that those in Group II weighed on an average only 4 pounds more during the first period than they did during the second period, shows that the daily ration containing 1.92 pounds of protein met the needs of the cows for milk-production better than did the ration fed to Group I containing on an average only 1.28 pounds of protein per cow. Group I received daily 13.45 pounds per cow of digestible matter reduced to a carbohydrate equivalent, and returned 4.15 pounds of product, or 1 pound of product to 3.24 pounds of nutriment consumed. Group II received daily 14.85 pounds of nutriment per cow and returned 4.57 pounds of product, or 1 pound of product to 3.25 pounds of nutriment consumed. Each group returned products proportionate to the feed consumed, but Group I sustained a marked loss, while Group II practically maintained an equilibrium in live weight. The average weight of Group I was 852 pounds, while Group II averaged 878 pounds per cow, showing that Group II in addition to returning products proportionally equal to Group I, provided the food of maintenance for 1,122 more pounds of live weight.

So far as the general appearance of the groups of cows was concerned, there seemed to be little difference; both appeared to be in good physical condition, although those in Group I were a little more spare than those in Group II. This phase of the experiment was carefully considered by W. M. Liggett, the Director, Professor Harry Snyder, Station Chemist, Dr. M. H. Reynolds, Station Veterinarian, and the writer.

On February 22 the experiment was discontinued because the supply of the various feeds had been exhausted and a new supply of similar kind and grade was not available.

THE WINTER OF 1903-1904

In view of the fact that the experiments in nutrient requirements of dairy cows in milk-production during the winters of 1901-1902 and

1902-1903 could not be carried on as long as is necessary to get definite results, it was decided to continue it during the winter of 1903-1904.

Special effort was made to have the cows fresh early in the fall, but of those that received a light protein ration, only Topsy II and White were fresh October 4, when the experiment began. Leoma and Sweet C were added to Group I October 4. Tricksey C's record began October 24, and Houston II was assigned to Group I, November 9. The others that were in the low-protein group during the winter of 1902-1903, either failed to freshen in time for the experiment or were not doing normal work. The cows in Group II are the same that were in Group II the winter of 1902-1903, except that Cylene aborted in July and Fay did not freshen until December 24—too late to be listed in the experiment.

Group I received a grain mixture of 3 parts each of ground corn, barley, and oats, and 1 part oil meal. Group II received a grain mixture of 3 parts each of gluten meal, ground barley, and oats, and 1 part oil meal. The roughage fed during the experiment was choice upland prairie hay and corn silage. Mangels were fed until February 14. The experiment closed the evening of April 17, covering a period of 196 days. No change was made in the grain mixture and no change in the feed except that no roots were fed after February 14.

TABLE 4

AVERAGE WEIGHT OF DRY MATTER, FEED CONSUMED EACH DAY, DAYS IN TRIAL, AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Roots	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Group I							
Houston II.....	7.4	4.0	35.9	8.2	18.86	154	817
Leoma.....	7.2	4.0	32.7	9.6	18.15	196	859
Lou II.....	8.1	5.0	42.0	11.1	22.04	196	888
Sweet C.....	7.1	4.0	34.0	9.5	18.36	196	801
Topsy II.....	7.3	5.0	38.2	10.0	20.39	196	845
Tricksey C.....	7.4	4.6	39.0	9.4	20.17	175	843
White.....	7.2	4.5	38.1	9.8	19.78	196	956
Average.....	7.4	4.4	37.1	9.7	19.68	187	858
Group II							
Betty C.....	7.1	4.0	35.6	9.5	18.66	196	782
Dora F.....	10.0	6.0	56.0	14.0	28.00	196	1,315
Duchess P. P....	7.1	5.0	42.0	9.7	20.99	196	876
Klondike.....	7.2	5.0	42.1	13.3	21.54	196	1,046
Nora.....	7.1	4.0	35.4	9.5	18.69	196	734
Pride III.....	7.1	4.0	36.0	9.2	18.75	196	796
Star.....	6.2	4.0	36.0	8.4	17.92	196	798
Average.....	7.4	4.6	40.4	10.5	20.65	196	907

TABLE 5

AVERAGE DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	DIGESTIBLE NUTRIENTS IN FEED			MILK	FAT		SOLIDS-NOT-FAT
	Crude Protein	Carbo-hydrates	Ether Extract		P. ct.	Lbs.	
	Lbs.	Lbs.	Lbs.	Lbs.			Lbs.
Group I							
Houston II.....	1.26	10.62	0.39	22.6	4.89	1.107	2.06
Leeoma.....	1.33	10.14	.37	21.0	5.57	1.170	1.93
Lou II.....	1.45	12.38	.44	35.5	2.70	.957	2.87
Sweet C.....	1.23	10.35	.37	21.4	4.40	.941	1.93
Topsy II.....	1.32	11.41	.40	24.9	3.52	.879	2.15
Tricksey C.....	1.32	11.31	.40	25.0	4.52	1.130	2.21
White.....	1.30	11.10	.39	17.0	4.66	.790	1.52
Average.....	1.32	11.04	.39	23.9	4.17	.996	2.10
Group II							
Betty C.....	1.83	9.94	.33	20.0	4.62	.924	1.80
Dora F.....	2.67	14.92	.48	36.1	3.21	1.160	2.94
Duchess P. P....	1.93	11.15	.35	19.7	5.47	1.075	1.81
Klondike.....	1.99	11.49	.36	16.3	5.69	.927	1.50
Nora.....	1.83	9.95	.33	24.6	4.77	1.176	2.24
Pride III.....	1.84	9.98	.33	23.4	4.60	1.077	2.13
Star.....	1.68	9.53	.31	18.3	4.85	.887	1.72
Average.....	1.97	10.99	.36	22.6	4.57	1.032	2.02

The average daily consumption of the cows in Group I was 1.32 pounds of crude protein, 11.04 pounds of carbohydrates, and 0.39 pound of ether extract and the return was 23.9 pounds of milk, containing 0.996 pound of butter fat and 2.10 pounds of solids-not-fat, while Group II received daily 1.97 pounds of crude protein, 10.99 pounds of carbohydrates, and 0.36 pound of ether extract and returned 22.6 pounds of milk containing 1.03 pounds of butter fat and 2.02 pounds of solids-not-fat. The dairy products returned were satisfactory considering the amount of feed consumed, the length of time the experiment covered, and the conditions under which the cows were working. The record of Group I is of special interest as the cows in that group yielded daily, on an average, 23.9 pounds of milk containing 0.996 pound of butter fat and 2.1 pounds of solids-not-fat per cow, for a period of 196 days with a ration containing only 1.32 pounds of crude protein.

A remarkable record in the group is that of Leeoma, who gave, on an average, 1.17 pounds of butter fat daily and 1.93 pounds of solids-not-fat, with a ration containing 1.33 pounds of crude protein. Another is that of Lou, who yielded 35.5 pounds of milk daily with only 1.45 pounds of crude protein. The record of Tricksey is of special interest as this was the third consecutive winter that she had been

subjected to a low-protein ration. The following is a summary of her record for the three winters:

TABLE 6

DIGESTIBLE NUTRIENTS CONSUMED AND PRODUCTS YIELDED PER DAY BY TRICKSEY

YEARS	DAYS	DIGESTIBLE NUTRIENTS IN FEED			MILK	FAT	SOLIDS-NOT-FAT
		Crude Protein	Carbo-hydrates	Ether Extract			
1901-1902.....	98	Lbs. 1.35	Lbs. 11.91	Lbs. 0.54	Lbs. 28.5	Lbs. 1.198	Lbs. 2.49
1902-1903.....	84	1.30	11.64	.47	29.0	1.204	2.50
1903-1904.....	175	1.32	11.31	.40	25.0	1.130	2.21

A better expression of the comparative efficiency of the two rations fed can be made by reducing the daily average nutrients consumed, and the dairy products yielded by each cow in the two groups to a common factor and calculating the net nutriment available for product, the product yielded, the nutriment required for a unit of product, and the effect on the live weight of the cows.

TABLE 7

AVERAGE AMOUNT OF NUTRIMENT, NUTRIMENT FOR MAINTENANCE AND AVAILABLE FOR PRODUCT, PRODUCT YIELDED, AND NUTRIMENT PER POUND OF PRODUCT

Cow	NUTRIMENT DAILY	NUTRIMENT		PRODUCT YIELDED	NUTRIMENT PER POUND OF PRODUCT	LIVE WEIGHT	
		For Maintenance	For Product			Period	
						I	II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Group I							
Houston II.....	12.74	6.47	6.27	4.55	1.38	845	789
Leoma.....	12.28	6.80	5.48	4.56	1.20	896	835
Lou II.....	14.80	7.03	7.77	5.02	1.55	905	860
Sweet C.....	12.39	6.34	6.05	4.05	1.49	814	788
Topsy II.....	13.61	6.69	6.92	4.13	1.67	850	848
Tricksey C.....	13.51	6.68	6.83	4.75	1.44	863	821
White.....	13.26	7.57	5.69	3.30	1.72	955	960
Average.....	13.23	6.80	6.43	4.34	1.48	875	843
Group II							
Betty C.....	12.50	6.25	6.25	3.88	1.61	772	792
Dora F.....	18.64	10.41	8.23	5.55	1.48	1,284	1,347
Duchess P. P.....	13.85	6.94	6.91	4.23	1.63	884	868
Klondike.....	14.28	8.30	5.98	3.58	1.67	1,032	1,061
Nora.....	12.51	5.81	6.70	4.89	1.37	735	733
Pride III.....	12.54	6.30	6.24	4.55	1.37	804	786
Star II.....	11.89	6.32	5.57	3.71	1.50	788	807
Average.....	13.74	7.19	6.55	4.34	1.51	900	913

From Table 7 it is found (1) that members of Group I which received a ration containing 1.32 pounds of crude protein per cow, consumed daily 13.23 pounds of nutriment; (2) that the amount calculated for daily maintenance was 6.80 pounds; (3) that 6.43 pounds were available for milk-production; (4) that the daily average production of milk solids was 4.34 pounds; and (5) that 1 pound of product was obtained to 1.48 pounds of nutriment, that is, of the nutriment available daily for product, 1 pound appeared in the product as milk solids and half a pound appears to have been expended in the process of production.

On examination of the average weights of the different cows in Group I, in the two periods, it will be seen that all but one weighed less during the last half of the experiment than during the first half, and that the cow that lost most in live weight used the least net nutriment for a pound of product. Leeoma had 5.48 pounds of net nutriment available for production daily, she yielded 4.56 pounds of product, and had only 1.20 pounds of nutriment for the production of a pound of product. She weighed on an average 61 pounds less the second period, showing that she was short of protein, or the amount of nutriment required for production, and had to sacrifice some substance in her body; or that she used a portion of the nutriment for product that she should have used for maintenance, leaving the maintenance ration short of her needs, and therefore lost in body weight. Topsy II had available 1.67 pounds of net nutriment for the production of a pound of product and almost maintained her normal body weight, showing that with the ration they were getting, 1.67 pounds of nutriment was nearly the amount of net nutriment required for the production of 1 pound of product, and maintain an equilibrium in live weight. This is confirmed by White, receiving 1.72 pounds of net nutriment per pound of product yielded, and making a slight gain in weight. But the group on the average had only 1.48 pounds of net nutriment per pound of product and because of the shortage the group lost in weight.

From the same table it is found that cows in Group II, which received a ration containing 1.97 pounds of crude protein, consumed daily 13.74 pounds of nutriment. The amount calculated for daily maintenance was 7.19 pounds, and 6.55 pounds of nutriment was available for milk-production. The daily average production of milk solids was 4.34, being exactly the same amount of product as that yielded by Group I. A pound of product was obtained to 1.51 pounds of nutriment and there was a slight gain in live weight, showing that the protein and the total nutriment provided met the requirements of the cows. Special attention is called to the fact that Group II during the winter of 1902-1903 returned a pound of dairy product to 1.73 pounds of net

nutriment, while Group II during the winter of 1903-1904 returned a pound of dairy product to 1.51 pounds of net nutriment. This is doubtless largely due to the fact that more roots were fed and for a longer time than during the winter preceding, requiring the expenditure of less energy in mastication and digestion.

Reviewing the results obtained from the two groups, we find that Group I, weighing 858 pounds and receiving daily a ration containing 13.23 pounds of nutriment, returned a pound of product to 3.05 pounds of nutriment and weighed on an average 32 pounds less during the second period than they did during the first; while Group II, weighing 908 pounds and receiving daily a ration containing 13.74 pounds of nutriment, returned a pound of product to 3.16 pounds of nutriment and weighed on an average 13 pounds more during the second period than they did during the first.

Since both groups returned the same amount of dairy product, and Group I, with a relatively larger ration than Group II, lost in body weight, while Group II gained in weight, it follows that the loss in body weight of Group I was caused by a shortage in the protein supply.

The data obtained also show that cows with strong dairy heredity, under careful and skillful handling, may for long and repeated trials return dairy products in excess of the amount provided for in the feed, at the sacrifice of body weight and yet apparently maintain normal physical tone.

After the close of the experiment, the cows were carefully inspected with reference to their physical condition by Director Liggett, Professor M. H. Reynolds, Station Veterinarian, and Professor Harry Snyder, Station Chemist, with the conclusion that the cows receiving the low-protein ration, though rather spare, were apparently in fine physical condition.

As the final results of these experiments had a direct bearing on the fundamental principles of feeding for milk-production as well as the volume and economy of production, it was deemed of great importance that the physical condition of the cows in the two groups be submitted to others of high repute in such matters.

The Hon. W. D. Hoard, of Fort Atkinson, Wisconsin, Editor of *Hoard's Dairyman*, and Professor W. A. Henry, Director of the Wisconsin Experiment Station, were invited to inspect the cows with special reference to their physical condition. Both accepted the invitation and the day was set for the inspection. At the appointed time Professor Henry reported that Governor Hoard was unable to accompany him but would come a few days later. Written directions were sent to the dairy stock foreman to bring the cows used in the feeding experiment to the stock lecture room in the basement of Dairy

Hall in pairs, one from each group in the following order:

Houston II	from Group I and Betty C.	from Group II
Fay	from Group I and Cylene	from Group II
Lou II	from Group I and Dora F.	from Group II
Leeoma	from Group I and Duchess P.P.	from Group II
Sweet Cicily	from Group I and Topsy II	from Group I
Tricksey C.	from Group I and Pride III	from Group II
Trust	from Group I and Trusty Lee	from Group II
White	from Group I and Star II	from Group II

The order in which they were to be brought into the lecture room for inspection was known only to the author and the stock foreman. Only two cows were in the room at a time, affording ample opportunity to make a thorough examination for a decision as to which one received the low-protein ration. Dean Henry gave each pair a careful and thorough inspection, but from the decisions made it was evident that there was no apparent difference in their physical condition. He requested that the two groups be turned to adjoining paddocks near by so that he could compare the two groups in the open. This was done and, after looking them over carefully, he said: "If I should come by on the highway and see the cows in this paddock I would say, 'there is a lot of fine cows in good working condition,' and if I should pass on and see this other group in a neighbor's yard, I would say, 'there is another lot of fine cows in good working condition but a trifle spare.'"

In a few days Governor Hoard came to University Farm to inspect the cows. Word was sent to the stock foreman to repeat the program given when Dean Henry inspected them. Governor Hoard, Dean Liggett, and Professor Snyder accompanied the writer to the stock room and found Betty and Houston there. The Governor gave both a very careful examination, feeling the coat and skin on various parts of the body. Finally, putting his hand on Betty's back, he said: "This is the one." The writer shook his head and the Governor said: "No?" and again receiving a negative sign, he repeated the examination and then said: "That is all." The cows were led out and Fay and Cylene brought in. Going over them in the same way, paying little attention to the appearance of the cows, he pointed to Fay, saying: "That is one on the low-protein ration." The writer, affirming the decision, directed that they be led out and Lou II and Dora F. brought in. After giving only a cursory examination, Governor Hoard pointed to Lou II as the one. The decision again being affirmed, the cows were led out and Leeoma and Duchess P.P. brought in. These in turn received very careful and extended examination, with some indications of doubt, but finally Leeoma was selected and, upon receiving an affirmative reply, the Governor said: "I believe I have got them." The

next pair brought in was Sweet C. and Topsy II. He went over them very carefully, stopped and looked at them a moment, and then reëxamined them repeatedly, passing the skin between thumbs and fingers as he stood between the two cows, at the same time examining one with the right hand and the other with the left; finally he said, "It's a guess. This is the one," pointing to Topsy. "It's both," remarked the writer. The Governor manifested great satisfaction and said, "I told you it was a guess, that I couldn't differentiate between them." As the other pairs were brought to him he had little difficulty in pointing out the ones fed on a low-protein ration. Governor Hoard did not volunteer an explanation as to how he distinguished members of one group from those of the other. He was not then requested to do so; but meeting him in St. Louis during the Louisiana Purchase Exposition, the writer asked him for an explanation. He answered: "By the feel of the skin. Of the first two cows one had a skin of ordinary thickness, while the other had a very thin skin. The first time it was a trial, I pointed to one and you shook your head. I then examined them again and after that I selected the one with a thin skin."

The decisions established the fact that in general appearance, the two groups were closely matched. The only difference, so far as could be discerned with the eye, was that the cows of one group were a trifle sparer than those of the other; but that there was a difference in their physical condition was shown by Governor Hoard's decisions. There was also some significance in his pointing out Topsy II as the one of the low-protein group when both had received a low-protein ration, because this was Topsy's second and Sweet Cicily's first winter on a low-protein ration. The same was the case when he betrayed some doubt before finally pointing to Leeoma as the one receiving the low-protein ration, as this was the first winter she was given a low-protein ration and was also in high flesh when she freshened and had shrunk in yield to a point where an equilibrium had been reached between the milk solids yielded and the net nutrients provided in the daily ration, some nine weeks before the close of the experiment.

THE WINTER OF 1904-1905

After inspecting the cows employed in the experiment on low- and medium-protein rations during the winter of 1903-1904, Professor W. A. Henry, when asked what suggestions he had to offer in regard to the experiment, promptly replied: "Try it another winter." As this was in accordance with the writer's plans, the experiment was continued along similar lines during the winter of 1904-1905 and the cows lined up in the same groups as far as possible. Euroma, Trust, and Trusty Lee had the low-protein ration during the winter of 1903-

1904, but their records were not included in the tables because they freshened too late or were for other reasons not available. Houston II and Fay were returned to Group II where they had been originally, though both freshened rather late for satisfactory results. In Group I, Leeoma freshened 28 days and Trust 14 days after the experiment began. The herd as a whole started in with a lower yield than had been the case in previous years. This was specially noticeable with those that had been two or more winters on the low-protein ration. Euroma failed to get in calf and was therefore giving only half her usual milk flow. Lou II and Topsy II gave only half their usual flow when fresh, while the others in the group gave about two thirds their usual flow when fresh.

Group I received a grain mixture composed of 4 parts ground corn, 3 parts ground barley, 2 parts ground oats, and 1 part oil meal. Group II received a grain mixture composed of 4 parts gluten feed, 3 parts ground barley, 2 parts ground oats, and 1 part oil meal. The roughage fed was choice upland prairie hay and corn silage from corn planted in drills and cut when in the milk stage. The experiment began October 31 and closed April 30, covering a period of 26 weeks. No change was made in the grain mixture until the morning of March 13, when the 4 parts corn in the grain mixture for Group I was replaced by 4 parts gluten feed, making the grain mixture for both groups the same. There was also marked regularity in the quantity of feed given in the daily rations. Half the feed was given in the morning and half in the evening. The quantity of feed given to each cow was so adjusted that each mess was eaten up clean. This has reference to silage and hay as well as to grain. All feeds are purchased through regular commercial channels and are the standard grades for feeding.

TABLE 8

AVERAGE AMOUNT OF FEED AND DRY MATTER CONSUMED PER DAY, DAYS IN TRIAL, AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Group I	October 31, 1904 to March 12, 1905					
Euroma	6.1	5.8	32.7	17.47	133	760
Leeoma	9.6	7.7	26.4	20.93	98	792
Lou II	10.0	5.9	41.4	22.81	133	872
Sweet C.	8.3	6.5	32.4	20.01	133	790
Swiss	8.0	5.9	39.8	20.76	133	1,006
Topsy II	9.9	5.9	35.4	21.44	133	820
Tricksey C.	9.6	6.0	42.7	22.89	133	855
Trust	9.6	8.9	23.0	21.27	112	706
Trusty Lee	6.0	5.9	27.5	16.38	133	683
White	8.0	5.9	37.5	20.27	133	880
Average	8.5	6.4	33.9	20.42	127	816

TABLE 8—Continued

Cow	Grain	Hay	Silage	Dry Matter	Length of Trial	Live Weight
Group I March 13 to April 30, 1905						
Euroma.....	6.0	6.0	30.0	17.16	49	793
Leeoma.....	11.0	6.5	28.0	21.59	56	808
Lou II.....	10.0	6.0	40.0	22.82	49	914
Sweet C.....	8.7	8.0	32.0	21.80	49	789
Swiss.....	8.0	6.0	40.0	21.06	49	1,099
Topsy II.....	10.0	6.0	31.0	20.86	49	901
Tricksey C.....	9.0	6.0	42.0	22.31	49	912
Trust.....	11.0	10.0	26.5	24.45	56	721
Trusty Lee.....	6.0	6.0	24.6	16.00	49	711
White.....	8.0	8.0	36.0	20.21	49	923
Average.....	8.8	6.8	33.0	20.83	50	857
Group II October 31 to April 30, 1905						
Betty C.....	8.0	5.9	36.7	20.29	182	766
Dora F.....	11.9	7.8	54.3	29.22	182	1,298
Duchess P. P.....	8.0	6.0	44.3	21.97	182	890
Fay.....	9.8	9.0	37.9	24.95	140	880
Houston II.....	8.6	6.0	30.7	19.66	154	838
Klondike.....	6.0	5.8	42.4	19.67	182	1,071
Nora.....	8.0	5.9	39.4	20.87	182	752
Pride III.....	8.0	5.9	39.8	20.96	182	793
Star II.....	7.9	6.0	36.2	20.17	168	817
Average.....	8.5	6.5	40.2	21.97	173	901

TABLE 9

AVERAGE POUNDS OF DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	Crude Protein	Carbo-hydrates	Ether Extract	Milk	Fat	Solids-Not-Fat
Group I October 31, 1904 to March 12, 1905						
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.
Euroma.....	1.049	9.852	0.405	13.1	5.65	0.740
Leeoma.....	1.333	12.021	.520	24.4	4.92	1.201
Lou II.....	1.479	13.228	.576	22.1	2.54	.562
Sweet C.....	1.274	11.467	.487	25.0	3.93	.982
Swiss.....	1.288	11.871	.502	14.2	4.54	.644
Topsy II.....	1.416	12.462	.548	20.0	3.49	.698
Tricksey C.....	1.463	13.218	.571	20.9	4.81	1.005
Trust.....	1.397	12.124	.519	26.5	3.74	.992
Trusty Lee.....	1.001	9.256	.382	17.2	4.56	.785
White.....	1.267	11.599	.492	20.6	4.43	.912
Average.....	1.297	11.710	.500	20.4	4.18	.852
Group I March 13, 1904 to April 30, 1905						
Euroma.....	1.405	9.242	.376	12.8	5.3	.678
Leeoma.....	2.164	11.853	.527	22.4	5.14	1.151
Lou II.....	2.100	12.522	.541	21.4	2.6	.557
Sweet C.....	1.911	11.760	.490	24.8	3.77	.936
Swiss.....	1.797	11.469	.480	14.1	5.12	.723
Topsy II.....	2.018	11.449	.502	19.8	3.84	.761
Tricksey C.....	1.964	12.191	.518	15.6	4.9	.764
Trust.....	2.284	13.171	.558	26.5	4.16	1.104
Trusty Lee.....	1.357	8.605	.352	16.1	4.64	.748
White.....	1.762	10.999	.463	16.3	4.9	.800
Average.....	1.876	11.326	.481	19.0	4.33	.822

TABLE 9—Continued

Cow	Crude Protein	Carbo- hydrates	Ether Extract	Milk	Fat	Solids- Not-Fat	
Group II							
October 31, 1904 to April 30, 1905							
Betty C.	1.764	11.05	.47	21.7	4.30	.932	1.90
Dora F.	2.588	15.99	.68	35.9	2.93	1.070	2.79
Duchess P. P. ...	2.104	11.96	.50	19.2	5.33	1.024	1.78
Fay.	2.165	13.46	.56	37.5	3.58	1.345	3.07
Houston II.	1.816	10.73	.46	23.6	4.73	1.118	2.16
Klondike.	1.509	10.63	.43	12.1	5.85	.705	1.11
Nora.	1.789	11.37	.48	20.4	4.80	.979	1.89
Pride III.	1.793	11.42	.48	22.7	4.30	.970	2.03
Star II.	1.750	10.97	.46	25.4	4.43	1.124	2.29
Average.	1.919	11.95	.50	24.3	4.24	1.030	2.11

From these tables it will be seen that the rations fed during the winter of 1904-1905 were standard as to quantity of the dry matter consumed daily, being at the rate of 24.8 pounds for Group I and 24.4 for Group II, per 1,000 pounds live weight. That Group I received daily 1.297 pounds of protein, 11.71 pounds of carbohydrates, and 0.5 pound of ether extract making a ration with a nutritive ratio of 1:9.8 Early in March it became apparent that some of the cows in Group I were beginning to show marked depression in physical tone. When turned into the runway for water they lacked the alertness and activity shown by those in Group II. Their eyes were dull, coats harsh, and skins drawn hard to their bodies. They were slow in both eating and drinking, did not seem to relish their food, and showed in every movement a low state of vitality. This was especially noticeable in the cows that gave milk containing a low percentage of fat. There was no marked decrease in flow of milk and yield of milk solids, which was doubtless partly due to the fact that they started their period of lactation in the fall at a very low yield, giving daily, on an average, the first week in the experiment, only 22 pounds of milk per day, testing 3.64 per cent fat and yielding for the week ended March 12 an average of 18.2 pounds of milk per day testing 4.22 per cent fat. The cows in Group I weighed, on an average, 829 pounds when the experiment began and 810 pounds the morning of March 13, so it was not by their yield or weight that their physical condition was judged but by their appearance and conduct.

On the morning of March 13 and until they were turned to pasture, the cows in Group I received a grain mixture containing 4 parts of gluten feed in place of 4 parts of corn meal, the ration containing the digestible nutrients indicated in Table 9.

From the same table it is seen that the ration consumed daily during the last 49 days by Group I contained 1.876 pounds of protein, 11.326 pounds of carbohydrates, and 0.481 pound of ether extract as

the average digestible nutrients per cow. The cows gave an average daily yield of 19 pounds of milk containing 0.822 pound of butter fat and 1.71 pounds of solids-not-fat.

From the table giving the nutrients consumed daily and dairy products yielded by Group II, it appears that the average daily ration of the cows contained 1.919 pounds of protein, 11.95 pounds of carbohydrates, and 0.5 pound of ether extract, and yielded 24.3 pounds of milk containing 1.03 pounds of butter fat and 2.11 pounds of solids-not-fat, being almost exactly the amounts received during the winter of 1903-1904.

A better comparison as to the efficiency of the two rations fed can be made by reducing the average of nutrients consumed and dairy products yielded each day by each cow in the two groups to a common energy value and calculating the net nutriment available for product, the product yielded, the nutriment required for a unit of product, and the effect on the live weight of the cows.

TABLE 10

AVERAGE TOTAL NUTRIMENT, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, PRODUCT YIELDED PER DAY, AND NUTRIMENT PER POUND OF PRODUCT

COW	NUTRIMENT DAILY	NUTRIMENT		PRODUCT DAILY	NET NUTRIMENT TO 1 LB. PRODUCT	LIVE WEIGHT	
		For Maintenance	For Product			Period	
						I	II
Group I							
October 31, 1904 to March 12, 1905							
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Euroma.....	11.792	6.019	5.773	2.848	2.027	759	760
Leeoma.....	14.498	6.296	8.202	4.892	1.677	812	773
Lou II.....	15.974	6.906	9.068	2.946	3.078	861	883
Sweet C.....	13.812	6.257	7.555	4.440	1.702	810	771
Swiss.....	14.263	7.967	6.296	2.727	2.310	975	1,037
Topsy II.....	15.084	6.494	8.590	3.276	2.622	807	833
Tricksey C.....	15.937	6.772	9.165	4.111	2.234	855	856
Trust.....	14.662	5.591	9.071	4.522	2.006	722	690
Trusty Lee.....	11.097	5.409	5.688	3.267	1.741	686	679
White.....	13.948	6.970	6.978	3.816	1.829	886	874
Average.....	14.107	6.471	7.636	3.684	2.073	817	816
Group II							
October 31 1904 to April 30, 1905							
Betty C.....	13.848	6.067	7.781	3.997	1.947	761	770
Dora F.....	20.074	10.280	9.794	5.197	1.884	1,281	1,316
Duchess P. P.....	15.164	7.049	8.115	4.084	1.987	884	897
Fay.....	16.857	6.970	9.887	6.096	1.622	876	883
Houston II.....	13.558	6.637	6.921	4.675	1.480	846	831
Klondike.....	13.055	8.055	5.030	2.696	1.866	1,064	1,078
Nora.....	14.215	5.956	8.259	4.093	2.018	752	753
Pride III.....	14.269	6.280	7.985	4.212	1.896	783	804
Star II.....	13.732	6.471	7.261	4.819	1.507	822	812
Average.....	14.978	7.085	7.893	4.427	1.783	896	905

Table 10 is compiled from the one giving the average of nutrients consumed and dairy products yielded by Group I during 19 weeks, and the one giving the same data for Group II during 26 weeks.

Comparing the results obtained from Group I during the two winters preceding, it is seen that the cows consumed more nutriment and returned less product. From a study of the tables it will be seen that the protein fed was 0.02 pound less than during the winter of 1903-1904, and 0.02 pound more than during the winter of 1902-1903. The increase in nutriment fed came, therefore, from an increase in the carbohydrates and fat.

Reviewing the record of Group II for the winter of 1904-1905, it is found that 14.978 pounds of nutrients were consumed daily. After deducting the amount calculated for food of maintenance there was available a daily average of 7.893 pounds of net nutriment for product; that 4.427 pounds of product were yielded daily, making 1 pound of product to 1.78 pounds of net nutriment available for product, with an average increase of 9 pounds in weight in the last half of the winter. The average yield of the group was satisfactory, being equaled only by Group II during the winter of 1902-1903 which covered a period of only 112 days, while the record of the herd for the winter of 1894-1895 covered a period of 173 days. The return of 1 pound of dairy product to 1.78 pounds of net nutriment reaches the maximum efficiency of rations made up with silage and wild hay or timothy for roughage and for concentrates, farm grains, bran, and enough oil meal or gluten feed to adjust it for milk-production.

As a summary of the results obtained by the two groups of cows during the three winters of experimental feeding, the following tables are submitted:

TABLE 11
SUMMARY OF RESULTS

Year	Protein	Carbo- hydrates	Fat	Nutri- tive Ratio	Butter Fat	Solids- Not- Fat	Total Product
	Lbs.	Lbs.	Lbs.		Lbs.	Lbs.	Lbs.
Group I							
1902-1903.....	1.28	11.16	0.46	1:9.5	0.931	2.06	4.15
1903-1904.....	1.32	11.04	.39	1:9.0	.996	2.10	4.34
1904-1905.....	1.30	11.71	.50	1:9.8	.852	1.81	3.73
Average.....	1.30	11.31	.45	1:9.5	.926	1.99	4.07
Group II							
1902-1903.....	1.92	11.86	.48	1:6.7	1.050	2.21	4.57
1903-1904.....	1.97	10.99	.36	1:6.0	1.032	2.02	4.34
1904-1905.....	1.92	11.95	.50	1:6.8	1.030	2.11	4.43
Average.....	1.94	11.57	.48	1:6.5	1.037	2.11	4.44

From the above summaries, comparing the results obtained from Group I, fed on a very wide ration, and Group II, fed on a medium-protein ration, it appears that Group I with only 1.3 pounds of protein daily, having a nutritive ratio of 1:9.5, yielded on an average 0.926 pound of butter fat and 1.99 pounds of solids-not-fat or 4.07 pounds of total product equivalent to solids-not-fat, while Group II, fed on a medium-protein ration containing 1.94 pounds of protein daily, having a nutritive ratio of 1:6.5, yielded on an average 1.037 pounds of butter fat and 2.11 pounds of solids-not-fat, or the equivalent of 4.44 pounds of solids-not-fat.

So far as the yields of dairy products are concerned, there was little difference and it would ordinarily have been considered a negligible quantity. Especially was this the case with the results secured during the winter of 1903-1904 when the experimental feeding covered over 200 days with exactly similar results from both groups with the exception that the cows in Group I had an average weight of 32 pounds less the last half of the experiment than they did the first half. It was fortunate that some of the cows in the herd were kept on low-protein rations for several consecutive winters to study the cumulative effect of low-protein rations and that the results of the experiments were measured not only by the dairy products yielded but by a close study of the effect on the physical condition of the cows as well. This phase of the experiment received special emphasis through the remarkable decisions made by Governor Hoard described in the preceding pages.

Since the gain in body weight by Group I in 1904-1905, after the change of ration, was very marked, tables are submitted giving the average daily nutrients consumed during seven weeks preceding the change in the ration and seven weeks following the change.

From Table 12 it is seen that there is no gain in weight of the cows during the 49 days preceding the change in the grain mixture. The average weight was 815 pounds, just as it was during the first half of the experiment. The cows consumed 20.84 pounds of dry matter daily, containing 1.333 pounds of digestible protein, 11.93 pounds of carbohydrates and 0.51 pound of fat. They yielded 18.7 pounds of milk, 0.81 pound of butter fat, and 1.68 pounds of solids-not-fat, per day. Reducing the nutrients consumed and dairy products yielded to a common energy value gives 14.385 pounds of nutriment and 3.502 pounds of dairy products daily, or a yield of 1 pound of dairy products from 4.11 pounds of nutriment, and scarcely maintaining live weight. The ration fed during the 49 days had a nutritive ratio of 1:9.7.

On the first morning of the twentieth week, the 4 pounds of corn meal were replaced by 4 pounds of gluten feed which is a ground corn

product from which much of the starch has been taken in the manufacture of glucose and some of the fat in the manufacture of corn oil from the hearts or chits of the corn kernels. This changed the nutrients in the ration as shown in Table 12.

TABLE 12

WEIGHT PER COW, DRY MATTER CONSUMED, AND PRODUCTS YIELDED PER DAY

WEEK	WEIGHT	DRY MATTER	NUTRIENTS DAILY			DAIRY PRODUCTS YIELDED		
			Protein	Carbo- hydrates	Fat	Milk	Butter Fat	Solids- Not-Fat
Nutritive Ratio of 1:9.7								
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
13th.....	827	20.00	1.278	11.49	0.49	19.4	0.838	1.73
14th.....	816	20.95	1.331	11.97	.51	18.9	.817	1.70
15th.....	804	21.19	1.355	12.10	.51	18.6	.825	1.68
16th.....	818	20.88	1.342	11.96	.51	18.9	.814	1.72
17th.....	820	20.92	1.343	11.98	.51	18.8	.804	1.68
18th.....	813	21.01	1.347	12.03	.51	18.4	.786	1.62
19th.....	810	20.92	1.338	11.97	.51	18.2	.786	1.64
Average...	815	20.84	1.333	11.93	.51	18.7	.810	1.68
After Change to Nutritive Ratio of 1:6.7								
20th.....	817	21.10	1.892	11.44	.48	18.1	.778	1.64
21st.....	832	20.64	1.872	11.23	.48	19.2	.802	1.72
22nd.....	847	20.81	1.879	11.32	.48	19.6	.849	1.79
23rd.....	862	20.73	1.864	11.27	.48	19.2	.833	1.73
24th.....	871	20.73	1.864	11.27	.48	18.8	.819	1.68
25th.....	880	20.81	1.879	11.32	.48	18.8	.824	1.71
26th.....	882	21.07	1.890	11.46	.49	18.9	.829	1.70
Average...	854	20.84	1.848	11.33	.48	18.9	.819	1.71

The nineteenth week closed Sunday evening, and Monday morning, March 13, the ten cows averaged 810 pounds in weight. During the 49 days following, they consumed daily, on an average, 20.84 pounds of dry matter, exactly the amount consumed the preceding 49 days, containing 1.848 pounds of protein, 11.33 pounds carbohydrates, and 0.48 pound of fat, and yielded on an average 18.9 pounds of milk, 0.819 pound of butter fat, and 1.71 pounds of solids-not-fat. Reducing the nutrients consumed and products yielded to a common factor gives 14.238 pounds of nutriment and 3.553 pounds of dairy products a day, or a yield of 1 pound of dairy products from 4.01 pounds of nutriment and an average gain in body weight per cow of 72 pounds during 49 days, or 1.47 pounds per day, while the increase of dairy products was only 0.05 pound. By narrowing the nutritive ratio of the ration to 1:6.7 the efficiency of the ration was increased enough to provide for the gain in body weight in addition to maintaining the yield of dairy products. It appears that with the cows that had been on the very-low-protein rations for from two to four winters, the impoverished con-

dition of the nitrogenous substances of the body was so great that they were unable to give an increased yield of milk until the body had been restored to normal condition.

THE WINTER OF 1905-1906

Pending investigations dealing with the composition of milk, the feeding experiments were continued along lines similar to those covering the stall feeding from the fall of 1901 to the spring of 1905, except that the herd was not divided into groups, and the ration was so adjusted that the average cow in the herd would receive approximately 1.75 pounds of digestible protein per day.

In the autumn of 1905, the herd appeared in fair condition, and it was the intention to select 20 cows for experimental feeding, but of these, one aborted; another, a heifer, did not clean properly and failed to come to a normal flow; three freshened very late; and another for some reason shrank abnormally in milk, and made rapid gain in weight. Among those that made satisfactory records were five cows that had been on low protein for several winters, while there were only two of those that had a medium protein that made good records, showing that in these cases low-protein rations for two or three winters caused no permanent injury.

Experimental feeding began October 9 and closed April 1, with the following exceptions:

Lou II	October 30—April 22	Faith	November 6—April 29
Letta P.	November 27—May 13	Houston II	Nov. 27—May 13
Fay	January 1—May 13	Doretta	July 15—May 13

Unfortunately four changes in the position of dairy stock foreman took place during the winter, and while each seemed to do his best, they lacked that familiarity with the characteristics of the different cows that is essential to best results. This is especially so when the quantity of the various feeds that is to be given to each cow is left to the judgment of the foreman, as was the case from the autumn of 1902 to 1908. The grain mixture was always prescribed by the writer, but the amount of grain and roots, if roots were available, was left to the judgment of the feeder, while the cows were to have what hay and silage they would eat up clean. Little change was made after the cow's feeding capacity was determined. This, however, was not the case with the grain mixtures, as some odd lots of feeds that were fed out during October and November, required the following changes in grain mixtures:

From October 9 to November 6, inclusive, corn, barley, and oats, 2 parts each, bran 4 parts, and oil meal and gluten feed 1 part each, with hay, silage, and roots.

From November 6 to November 19, inclusive, corn and barley 2 parts, bran 4 parts, and oil meal and gluten feed 1 part each, with hay, silage, and roots.

For the week ended November 26, corn and barley 2 parts each, bran 4 parts, and oil meal 1 part, with hay, silage, and roots.

From November 27 to May 13, corn 3, barley 2, bran 4, and oil meal 1, with hay, silage, and roots, except that the supply of roots was exhausted during the week which ended December 6. When the roots were discontinued, the grain ration was increased 1 pound the first week, and in case of most of the cows another pound was added the second week. There was a shrinkage in flow the first week without roots, but most of them recovered during the second week, when two pounds of grain was fed in lieu of 20 pounds of roots. The recovery, however, was more noticeable in the yield of butter fat than in the flow of milk. The hay fed during the winter was choice upland prairie, and the silage was from corn planted in drills.

TABLE 13

AVERAGE FEED AND DRY MATTER CONSUMED PER DAY, DAYS IN TRIAL, AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Roots	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Cylene.....	11.6	6.5	39.5	11.0	25.42	175	976
Doretta.....	8.9	7.7	31.3		21.58	119	910
Duchess P. P.	7.9	6.5	40.8	11.0	22.48	175	887
Euroma.....	6.9	5.1	31.0	8.0	18.12	175	783
Faith.....	9.1	6.4	33.8	6.0	21.60	175	884
Fay.....	8.9	9.0	21.5	1.6	20.83	133	844
Houston II.....	8.7	7.9	23.3	3.0	19.49	168	811
Letta P.....	7.8	5.0	26.3	2.0	17.25	168	604
Lou II.....	13.3	7.1	40.7	9.6	28.23	175	985
Nora.....	9.1	5.6	36.6	11.0	21.85	175	758
Pride III.....	8.0	5.5	38.0	11.0	21.02	175	854
Sweet C.....	11.0	6.3	37.0	11.0	24.27	175	864
Topsy II.....	11.0	6.4	41.5	11.0	25.34	175	935
Tricksey C.....	8.6	6.4	40.0	11.0	22.91	175	996
Trusty Lee.....	6.8	5.0	32.2	11.0	18.24	175	735
White.....	8.4	5.5	36.6	11.0	21.14	175	1,037
Average.....	9.1	6.4	34.4	8.1	21.86	172	864

From the foregoing table it is seen that the cows consumed an average daily ration of 9.1 pounds of grain mixture, 6.4 pounds of hay, 34.4 pounds of silage, and 8.1 pounds of mangels. The average amount of dry matter consumed per day was 25.18 pounds, being just a trifle below the general standard. This is especially interesting since they were allowed what hay and silage they would take. On an average, the cows were in the experiment 172 days, and weighed 864 pounds.

TABLE 14

AVERAGE AMOUNT OF DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	NUTRIENTS FED			DAILY PRODUCTION			
	Protein	Carbo- hydrates	Fat	Milk	Fat		Solids- Not- Fat
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.	Lbs.
Cylene.....	2.00	15.50	0.594	30.95	3.07	0.951	2.55
Doretta.....	1.50	12.43	.488	28.14	2.91	.820	2.28
Duchess P. P....	1.61	12.75	.490	18.09	5.45	.987	1.65
Euroma.....	1.33	10.28	.402	15.67	5.56	.872	1.46
Faith.....	1.59	12.39	.493	24.70	3.54	.874	2.06
Fay.....	1.47	12.10	.468	31.93	3.52	1.125	2.56
Houston II.....	1.37	11.43	.434	21.82	4.68	1.022	1.93
Letta P.....	1.28	9.91	.407	18.16	5.65	1.027	1.68
Lou II.....	2.24	16.16	.672	44.79	2.84	1.271	3.66
Nora.....	1.67	12.38	.496	25.14	4.65	1.169	2.30
Pride III.....	1.56	11.91	.467	19.46	4.55	.887	1.77
Sweet C.....	1.90	13.81	.562	29.38	4.23	1.242	2.68
Topsy II.....	1.95	14.40	.583	32.36	3.79	1.226	2.85
Tricksey C.....	1.68	12.99	.507	17.49	5.36	.938	1.61
Trusty L.....	1.35	10.34	.402	18.55	4.80	.891	1.65
White.....	1.59	11.99	.476	18.18	5.01	.911	1.63
Average.....	1.63	12.55	.496	24.68	4.11	1.013	2.145

It is seen from the foregoing table that the average daily consumption of the cows was 1.63 pounds of digestible protein, 12.55 pounds of digestible carbohydrates, and 0.496 pound of ether extract, and that they yielded 24.68 pounds of milk, containing 1.013 pounds of butter fat and 2.145 pounds of solids-not-fat. This indicates a slight depression in yield, as 1.05 pounds of butter fat has been found to be a standard daily yield under methods and conditions that obtain in the Station herd. The nutritive ratio of the ration was approximately 1 : 8.4.

Again reducing the daily average nutrients consumed and milk solids yielded to a common factor, and calculating the net nutriment available for product and the net nutriment to a pound of product, we have the figures presented in Table 15.

Table 15 shows that the cows consumed an average daily ration containing 15.27 pounds of digestible nutriment, that 6.85 pounds were needed for the maintenance of the body, leaving 8.43 pounds available for product; that they yielded daily 4.425 pounds of milk solids, a product reduced to an equivalent of solids-not-fat, for product, and that the herd averaged 868 pounds per cow during the first half of the winter, and 861 pounds during the last half. The table indicates that cows require approximately 1.90 pounds of net nutriment to one pound of product. Cylene is charged with 2.36 pounds of nutriment to a pound of product, but the columns of weights show that she did not use all of it for milk, but applied some to gain in weight. Doretta

TABLE 15

NUTRIMENT, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, PRODUCT YIELDED, NET NUTRIMENT PER POUND OF PRODUCT AND PER DAY, AND AVERAGE WEIGHT DURING EACH HALF OF EXPERIMENT

Cow	NUTRIMENT DAILY	NUTRIMENT		PRODUCT DAILY	NUTRIMENT PER POUND OF PRODUCT	LIVE WEIGHT	
		Main-tenance	Product			Period	
						I	II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Cylene.....	18.81	7.73	11.08	4.690	2.36	958	997
Doretta.....	15.00	7.21	7.79	4.125	1.89	911	910
Duchess P. P....	15.44	7.02	8.42	3.871	2.18	896	878
Euroma.....	12.49	6.20	6.29	3.422	1.84	790	776
Faith.....	15.06	7.00	8.06	4.027	2.00	858	913
Fay.....	14.60	6.68	7.92	5.091	1.56	871	814
Houston II.....	13.75	6.42	7.33	4.230	1.73	839	783
Letta P.....	12.08	4.78	7.30	3.991	1.83	610	599
Lou II.....	19.88	7.48	12.40	6.520	1.90	956	935
Nora.....	15.14	6.00	9.14	4.930	1.85	768	748
Pride III.....	14.50	6.76	7.74	3.766	2.06	852	855
Sweet C.....	16.95	6.84	10.11	5.475	1.85	875	856
Topsy II.....	17.63	7.40	10.23	5.609	1.82	941	928
Tricksey C.....	15.78	7.89	7.89	3.721	2.12	987	1,005
Trusty Lee.....	12.57	5.82	6.75	3.655	1.85	738	732
White.....	14.63	8.21	6.42	3.680	1.74	1,036	1,039
Average.....	15.27	6.85	8.43	4.425	1.90	868	861

used 1.89 pounds of nutriment to a pound of product, and practically maintained her weight, showing that her ration was adjusted to her needs. Duchess P.P. used 2.18 pounds more than the normal amount, and still lost in body weight. This, however, was due to the fact that she had a severe attack of rheumatism. Euroma used 0.07 pound less daily and lost slightly in weight. She had calved in June, and had shrunk considerably in flow of milk during the summer and on this account her system did not call for much feed. Generally, a cow's appetite is controlled by the work she is doing. Fay came in late, and was not in the experiment the length of time required to recoup body weight, which is almost universally reduced during the early part of lactation. Lou consumed feed in proportion to her exceptionally large production, but failed to maintain her weight, doubtless because of a shortage in the protein supply in her ration, as milk having a very low fat content has a narrow nutritive ratio, as will appear later on. There may also have been a lack of proper distribution of grain to roughage for the highest efficiency.

It appears that 44.8 per cent of the nutriment was used for body maintenance, 55.2 per cent for product, 29 per cent appeared in the product, and 26.2 per cent was expended in energy to carry on the digestive processes of the productive part of the ration and the waste in the conversion of the crude protein in the feed to the true protein in the milk.

THE WINTER OF 1906-1907

In the autumn of 1906, the herd went on stall feed in fairly good average condition. Three aborted, Houston, the heifer Lola, and Trust. The latter did not recover in time to be listed in the record. Alzanka freshened in February, the heifer Loula in April, and the heifer Helen in June, and on this account, and because of their age, were not in condition to give normal results. Dora F. and Faith freshened 1 week late, Duchess P.P. 2 weeks, Pride III and Trusty Lee 3 weeks, Fay 6 weeks, and Euroma 7 weeks. The only abnormal temporary decrease in the flow of milk was by Dora F. during the week ending December 30, and by Houston II the first five weeks, which were not included in calculating her average record.

The grain ration was composed of 3 parts, by weight, of corn meal, 2 parts each of barley, bran, and gluten feed, and 1 part of oil meal. The record covers the period beginning with October 22, and closes with April 7. The roughage fed was choice upland prairie hay and corn silage, except that Daisy received 8 pounds of cut fodder corn per day from October 29 to February 25. A few mangels fed during the first two weeks are not listed in the feed consumed, but the nutrients they contained are included in the data. The quantity of feed fed from day to day was so nearly uniform, that the rations were practically fixed rations.

TABLE 16
AVERAGE AMOUNTS OF FEED AND DRY MATTER CONSUMED PER DAY, DAYS IN TRIAL, AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Dry Matter	Length of Trial	Average Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Alzanka.....	5.9	6.0	35.4	20.10	168	915
Cylene.....	12.5	7.2	37.7	28.36	168	1,137
Daisy.....	7.1	1.7	14.3	15.71	168	593
Dora F.....	10.6	4.0	45.4	25.47	161	1,273
Doretta.....	11.8	5.8	40.1	26.35	112	1,027
Duchess P. P.....	10.6	6.8	30.7	23.78	147	849
Euroma.....	9.8	7.2	28.6	22.81	119	855
Faith.....	7.9	8.9	42.3	25.52	161	990
Fay.....	12.4	7.7	29.0	25.71	119	890
Helen.....	5.0	6.0	29.1	17.66	168	734
Houston II.....	10.0	5.7	24.6	20.64	168	898
Lola.....	7.9	5.1	35.2	21.18	168	861
Lou II.....	12.5	5.1	39.2	26.59	168	978
Loula.....	8.0	6.6	32.2	21.74	168	781
Norabel.....	6.0	5.9	32.7	19.36	168	720
Pride III.....	10.0	5.5	28.0	21.32	147	811
Sweet C.....	12.9	4.8	32.4	24.53	158	909
Topsy II.....	11.4	5.7	38.7	25.99	168	936
Tricksey C.....	11.6	5.1	33.3	24.07	168	1,019
Trusty.....	8.0	6.0	33.1	21.42	168	873
Trusty Lee.....	10.4	7.8	23.2	22.51	147	800
White.....	8.4	4.0	41.2	22.40	168	1,112
Average.....	9.6	5.8	33.0	22.87	157	907

The cows ranged in weight from 593 to 1,273 pounds, and averaged 907 pounds. The grain consumed ranged from 5 pounds to 12.9 pounds and averaged 9.6 pounds per cow daily. All the cows received hay regularly, except the heifer Daisy that occupied a stall in the second division of the barn where fodder corn and silage were fed for roughage. Between October 29 and February 25 she received 952 pounds of fodder corn. She was then transferred to the first division of the barn, where the cows were receiving upland prairie hay instead of fodder corn. Beginning with February 25, and ending with April 7, and including the week ending October 28, she consumed 294 pounds of prairie hay. The daily average consumption of hay was 5.8 pounds, and of corn silage 33 pounds. The average amount of dry matter consumed per day was 22.87 pounds, being at the rate of 25.2 pounds per 1,000 pounds live weight.

The following table gives the food nutrients provided by the feed consumed, the pounds of milk yielded, and its butter fat and other solid contents:

TABLE 17
AVERAGE AMOUNT OF DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	NUTRIENTS FED			DAILY PRODUCTION			
	Protein	Carbo- hydrates	Fat	Milk	Fat	Solids- Not-Fat	
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.	Lbs.
Alzanka	1.30	11.27	0.516	15.9	4.88	0.775	1.46
Cylene	2.27	16.23	.787	27.3	3.37	.919	2.25
Daisy	1.27	9.02	.455	15.5	4.93	.765	1.51
Dora F.	1.98	14.65	.705	35.4	3.09	1.094	2.88
Doretta	2.06	15.18	.746	35.4	3.33	1.180	3.00
Duchess P. P.	1.84	13.54	.667	26.6	4.89	1.300	2.44
Euroma	1.72	12.90	.631	24.1	5.42	1.307	2.33
Faith	1.68	14.29	.662	25.2	3.56	.899	2.10
Fay	2.07	14.66	.733	39.3	3.75	1.474	3.30
Helen	1.13	9.84	.449	13.7	6.06	.829	1.30
Houston II.	1.67	11.82	.588	19.4	5.50	1.067	1.90
Lola	1.52	12.12	.574	24.2	3.37	.816	2.05
Lou II.	2.19	15.31	.752	38.6	2.91	1.123	3.17
Loula	1.55	12.25	.582	21.6	4.29	.923	1.98
Norabel	1.28	10.86	.501	15.3	5.78	.886	1.48
Pride III.	1.70	12.22	.607	27.6	4.43	1.223	2.50
Sweet C.	2.10	14.28	.724	31.2	4.34	1.354	2.92
Topsy II.	2.06	14.96	.726	29.7	3.79	1.126	2.67
Tricksey C.	1.98	13.92	.670	22.8	5.01	1.144	2.11
Trusty	1.54	12.13	.577	17.6	5.32	.935	1.64
Trusty Lee	1.76	12.71	.632	26.7	4.46	1.192	2.46
White	1.67	12.91	.607	23.7	4.88	1.160	2.18
Average	1.74	13.05	.631	25.3	4.22	1.068	2.26

From Table 17 it is seen that the daily digestible protein supply in the rations ranged from 1.13 to 2.27, and averaged 1.74 pounds, while

the digestible carbohydrates ranged from 9.02 to 16.23, and averaged 13.05 pounds, and the ether extract ranged from 0.449 to 0.787 and averaged 0.631 pound, or an average of 1.91 pounds digestible protein, 14.38 pounds of carbohydrates, and 0.695 pound of ether extract per 1,000 pounds live weight. An average milk yield of 25.3 pounds per day, testing 4.22 per cent fat and containing 1.068 pounds butter fat, and 2.26 pounds of solids-not-fat was secured. The average yield was a trifle above the standard, and was especially satisfactory in view of the fact that the table includes the record of 2 two-year-old, and 4 three-year-old heifers.

Again reducing the feed nutrients and the milk solids yielded daily to common factors, and showing the relation of food to product, and the effect on the live weight of the cows, Table 18 is submitted:

TABLE 18
AVERAGE AMOUNTS OF NUTRIMENT CONSUMED PER DAY, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, PRODUCT YIELDED, AND NET NUTRIMENT PER POUND OF PRODUCT

Cow	NUTRIMENT			TOTAL PRODUCT DAILY	NET NU- TRIMENT PER LB. OF PRODUCT	WEIGHT	
	Total Daily	For Main- tenance	For Product			Period	
						I	II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Alzanka.....	13.70	7.25	6.45	3.204	2.01	912	918
Cylene.....	20.23	9.00	11.23	4.318	2.60	1,118	1,156
Daisy.....	11.29	4.70	6.59	3.231	2.04	589	597
Dora F.....	18.18	10.08	8.10	5.342	1.51	1,283	1,261
Doretta.....	18.88	8.13	10.75	5.655	1.91	1,022	1,032
Duchess P. P....	16.85	6.72	10.13	5.365	1.89	865	832
Euroma.....	16.01	6.77	9.24	5.271	1.75	856	853
Faith.....	17.43	7.84	9.54	4.123	2.31	966	1,016
Fay.....	18.34	7.05	11.29	6.617	1.70	909	871
Helen.....	11.96	5.81	6.15	3.165	1.94	740	728
Houston II.....	14.78	7.11	7.67	4.301	1.78	909	887
Lola.....	14.90	6.82	8.08	3.886	2.08	843	880
Lou II.....	19.15	7.75	11.40	5.697	2.00	994	961
Loula.....	15.08	6.19	8.89	4.057	2.19	775	788
Norabel.....	13.25	6.19	7.55	3.473	2.11	720	720
Pride III.....	15.29	6.42	8.87	5.252	1.69	824	797
Sweet C.....	17.97	7.20	10.77	5.967	1.80	915	902
Topsy II.....	18.62	7.41	11.21	5.204	2.15	945	926
Tricksey C.....	17.37	8.07	9.30	4.684	1.99	1,007	1,031
Trusty.....	14.94	6.91	8.03	3.744	2.15	861	885
Trusty Lee.....	14.10	6.34	7.76	5.142	1.51	807	793
White.....	15.92	8.81	7.11	4.790	1.48	1,121	1,100
Average.....	16.18	7.19	8.99	4.663	1.92	908	906

Table 18 gives the average amount of nutriment consumed per day by each cow, the amount calculated for body maintenance, the nutriment available for product, the product yielded daily, the net nutriment consumed to a pound of product yielded, and the average weight

of the cows during each half of the period. The nutriment consumed daily ranged from 11.29 to 20.23 pounds, and averaged 16.18, being at the rate of 17.8 pounds per 1,000 pounds live weight, which is practically two pounds above the standard prescribed by Wolff. The amount calculated for maintenance of body ranges from 4.7 to 10.08, and averages 7.19 pounds. The nutriment available for product ranged from 6.15 to 11.4, and averaged 8.99 pounds. The product yielded daily ranged from 3.165 to 6.617 and averaged 4.663 pounds. The net nutriment consumed per pound of product yielded, ranged from 1.51 to 2.60 pounds. The cows that used relatively much nutriment per pound of product, also gained in weight, while those that used relatively little, lost in body weight. In the case of those that gained in weight, not all the net nutriment was used for dairy product, because some was diverted to gain in body weight, but the amount used for this purpose can not be given. The heifers also used some for growth. Daisy weighed 589 pounds during the first half of the experiment, and 597 during the last half, but she had enough net nutriment for the product she yielded and the growth she made. Helen made growth and yielded dairy products, but lost in weight because she lacked the amount of nutriment needed. Loss in weight in spite of growth indicated that more body substance was used for product and energy than was added to it by the growth made. Loula and Lola, like Daisy, made growth and had the net nutriment needed. The two columns giving the average weights of each cow during the two periods, do not show the amount of gain or loss. Some cows, when the milk flow has fallen below the supply of nutriment, gain very rapidly, while others gain very slowly, because of inherited temperament. That gain in weight by some cows is offset by loss in weight by others, seems indicated by the average results obtained. An equilibrium in the weight of the herd was maintained during the winter, and 1 pound of product was obtained from 1.92 pounds of net nutriment. That is, of the 1.92 pounds of net nutriment, 1 pound appeared in the product and 0.92 pound was expended in the process of mastication, digestion, and translocation of nutrients in feed to solids in milk.

It will be seen that of the daily average of digestible substances consumed 28.8 per cent appears in the milk solids, leaving 71.2 per cent expended in maintenance of body and for energy in carrying on the digestive processes. Of the 71.2 per cent it appears that 44.4 per cent was for maintenance and the balance for energy.

THE WINTER OF 1907-1908

The cows that were in normal condition were in even better working condition when exclusive stall feeding began than was the case the

fall preceding, but on account of abortion and other unfavorable conditions, some that had been employed in the experiment a number of years could not be included. Alzanka was a shy breeder, and did not freshen in time to be used in the experiment. The same was the case with Dora F.

Daisy carried her calf full time but it died in a few hours. She was apparently infected with abortion, as there was difficulty in getting her in calf. The same difficulty was experienced with Houston II, and she was allowed to remain farrow and bred the following fall, with the expectation that she would be used for experimental work during the winter of 1908-1909. The same was the case with Lola and Trust. Topsy II and Nora failed to come to normal milk flow, the former averaging only 13.8 pounds of milk during the winter, and Nora 16.1 pounds. Duchess P.P. suffered from rheumatism, but by careful handling she maintained nearly a normal flow, but experienced some loss in body weight, believed to be due chiefly to the fear and difficulty she had in stepping over the gutter, and while in the covered runway daily for water. This was in a measure mitigated by the fact that she was generally protected by an attendant while in the runway. Lou also was a timid cow, and the effect is reflected in the fact that the net nutriment she used per unit of dairy product was relatively large. Nora also used a relatively large amount of nutriment per unit of product, but for a different reason—she was continually finding trouble with other cows.

The records cover 24 weeks, except that Sweet C's is for 20 weeks, Doretta's and Easter's for 22 weeks, and Letta P.'s for 23 weeks, because they were not fresh when the experiment began.

From October 7 to November 24, inclusive, the grain mixture was composed of corn meal 4 parts, bran 4 parts, and oil meal 2 parts. From November 25 to the close of exclusive stall feeding, May 17, the grain mixture was composed of corn meal 4 parts, bran 3 parts, barley 1 part, and oil meal 2 parts. The roughage fed was choice upland prairie hay and corn silage, and during the week which ended on November 2, Cylene, Doretta, Lou II, and Tricksey C. received 34 pounds of mangels daily. The quantity of feed consumed daily was fairly uniform, considering the heavy feeding that obtained during the winter. The average amount of feed consumed daily by each cow, is given in Table 19.

The cows consumed an average daily ration of 9.9 pounds of grain, 9.9 pounds of hay, and 23.1 pounds of corn silage, containing 23.89 pounds of dry matter at the rate of 27.6 pounds per 1,000 pounds live weight. The decrease in the amount of corn silage consumed was caused by a shortage in the supply, so when stall-feeding began,

TABLE 19

AVERAGE AMOUNT OF FEED AND DRY MATTER CONSUMED PER DAY, DAYS IN TRIAL,
AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
Cylene.....	11.7	10.4	26.4	27.35	168	1,095
Doretta.....	11.8	10.6	27.2	27.91	154	1,075
Duchess P. P.....	9.9	10.8	24.4	25.05	168	824
Easter.....	10.4	10.0	24.4	24.03	154	897
Euroma.....	8.8	10.0	23.4	22.53	168	861
Fay.....	12.2	10.6	22.0	25.96	168	906
Hazel.....	8.0	9.3	20.4	21.15	168	820
Helen.....	8.7	9.8	20.0	21.86	168	734
Letta P.....	10.3	9.6	16.2	21.50	161	634
Lou II.....	11.4	8.6	26.3	25.49	168	877
Loula.....	11.2	11.1	25.2	27.08	168	809
Norabel.....	8.2	9.2	21.9	21.73	168	742
Pride III.....	9.7	9.3	21.7	23.00	168	809
Sweet C.....	11.3	11.6	23.7	25.88	140	840
Tricksey C.....	8.2	9.5	24.5	22.86	168	925
Trusty Lee.....	9.3	9.2	13.5	20.06	168	789
White.....	7.3	8.4	31.0	22.76	168	1,071
Average.....	9.9	9.9	23.1	23.89	164	865

less silage was allowed and as the cows received what hay they would take, the hay consumption was increased by 4.1 pounds over the amount taken the winter preceding, and one pound of hay was substituted for approximately 2.5 pounds of silage. Three-tenths of a pound more grain was also fed. The amount of silage and grain consumed were gauged by the feeder, the former being based upon the supply, and the latter upon the judgment of the feeder. During all the experiments, the rule has been to make no changes in rations during the week except in emergency cases, because the weekly feeding reports close with Sunday evening, and such changes as seemed necessary or advisable should begin Monday morning.

To suggest the conduct of the cows during the 24 weeks covered by the experiment with respect to the different quantities of feed taken, the following illustration is given:

TABLE 20

FEED CONSUMED EACH WEEK, AVERAGE POUNDS OF BUTTER FAT YIELDED PER DAY,
AND WEIGHT OF COW ON MONDAY MORNING, OCTOBER 3-MARCH 22

LETTA P.					LOULA				
Weight	Grain	Hay	Silage	Butter Fat	Weight	Grain	Hay	Silage	Butter Fat
Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
660	7	8	16	1.144	770	9	5	20	1.106
680	9	8	16	1.491	770	9	8	30	1.113
685	8	8	14	1.373	790	9	10	30	1.147

TABLE 20—Continued

LETTA P.					LOULA				
Weight	Grain	Hay	Silage	Butter Fat	Weight	Grain	Hay	Silage	Butter Fat
640	9	8	16	1.469	790	9	10	34	1.210
630	9	9	14	1.404	810	10	10	30	1.190
630	10	9	14	1.403	810	11	10	30	1.257
640	9	10	20	1.404	810	12	10	30	1.298
630	12	10	16	1.476	820	12	12	30	1.257
630	12	10	18	1.440	780	12	12	30	1.333
640	12	10	16	1.346	810	12	12	30	1.273
640	11	10	16	1.281	830	12	12	30	1.253
640	11	10	16	1.316	840	12	12	26	1.206
630	11	10	16	1.293	810	12	12	26	1.226
630	11	10	16	1.203	800	12	12	24	1.226
640	11	10	18	1.188	820	12	12	24	1.184
620	11	10	18	1.141	810	12	12	24	1.160
640	11	10	16	1.170	830	12	12	20	1.194
630	11	10	16	1.196	810	12	12	20	1.183
620	11	10	16	1.168	830	12	12	20	1.168
585	10	10	16	1.178	820	12	12	20	1.083
625	10	10	16	1.160	810	11	12	20	1.121
620	10	10	16	1.163	820	11	12	20	1.070
610	10	10	16	1.200	820	11	12	18	1.053
					820	11	12	18	0.994
634	10.3	9.6	16.2	1.287	809	11.2	11.1	25.2	1.179

The weekly records of feed consumed by Letta P. and Loula show fairly the maximum and minimum changes that occur during the winter. It required frequent changes to keep Letta P. from going off feed while few changes were made in Loula's ration. Letta P. lost approximately 50 pounds in live weight, while Loula gained about as much. Letta P.'s weight, Monday morning of the twenty-first week, indicates that she failed to get water the day preceding. The cows are always weighed after feeding and before watering.

TABLE 21

AVERAGE AMOUNTS OF DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	NUTRIENTS DAILY			DAILY PRODUCTION			
	Protein	Carbo- hydrates	Fat	Milk	Fat		Solids- Not- Fat
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.	Lbs.
Cylene.....	2.05	14.68	0.775	33.5	3.27	1.095	2.74
Doretta.....	2.08	15.00	.787	33.5	3.22	1.079	2.79
Duchess P. P...	1.79	13.33	.671	23.7	4.84	1.146	2.13
Easter.....	1.78	12.89	.608	26.8	4.47	1.196	2.49
Euroma.....	1.59	12.02	.565	20.2	5.37	1.084	1.94
Fay.....	2.02	13.96	.708	36.1	3.47	1.254	2.94
Hazel.....	1.49	11.21	.573	17.3	6.00	1.041	1.65
Helen.....	1.56	11.61	.579	20.8	5.49	1.143	1.89

TABLE 21—Continued

Cow	NUTRIENTS DAILY			DAILY PRODUCTION			Solids- Not- Fat
	Protein	Carbo- hydrates	Fat	Milk	Fat		
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.	Lbs.
Letta P.....	1.68	11.53	.563	22.9	5.61	1.287	2.16
Lou II.....	1.96	13.76	.739	37.3	2.58	.962	2.97
Loula.....	2.00	14.64	.759	30.2	3.91	1.179	2.64
Norabel.....	1.54	11.53	.596	21.5	5.20	1.119	1.97
Pride III.....	1.70	12.22	.630	25.1	4.08	1.025	2.23
Sweet C.....	1.93	13.85	.643	31.0	3.75	1.162	2.76
Tricksey C.....	1.53	12.19	.616	19.7	4.88	.959	1.76
Trusty Lee.....	1.55	10.71	.541	22.9	4.34	.995	2.04
White.....	1.50	12.11	.615	18.9	4.64	.878	1.67
Average.....	1.75	12.78	.645	26.0	4.21	1.094	2.28

From this table it is seen that the daily protein supply ranged from 1.5 to 2.08, and averaged 1.75 pounds. The carbohydrates ranged from 10.71 to 15 and averaged 12.78 pounds, while the ether extract ranged from 0.541 to 0.787, and averaged 0.645 pound. The yield of butter fat averaged 1.094 pounds, and solids-not-fat 2.28 pounds, or almost exactly the same as the yield of milk solids the winter preceding. The nutritive ratio averaged 1:8.1.

TABLE 22

AVERAGE AMOUNTS OF NUTRIMENT CONSUMED, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, PRODUCT YIELDED PER DAY, AND NET NUTRIMENT PER POUND OF PRODUCT

Cow	NUTRIMENT			TOTAL PRODUCT DAILY	NET NU- TRIMENT TO 1 LB. PRODUCT	WEIGHT	
	Total	Main- tenance	Prod- uct			Period	
						I	II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
Cylene.....	18.44	8.67	9.77	5.204	1.88	1,099	1,092
Doretta.....	18.81	8.51	10.30	5.218	1.97	1,064	1,085
Duchess P. P.....	16.60	6.53	10.07	4.709	2.14	827	821
Easter.....	16.01	7.10	8.90	5.181	1.72	893	901
Euroma.....	14.85	6.82	8.03	4.379	1.83	852	869
Fay.....	17.54	7.17	10.36	5.762	1.80	912	900
Hazel.....	13.96	6.49	7.46	3.992	1.87	811	830
Helen.....	14.45	5.81	8.64	4.462	1.94	729	739
Letta P.....	14.45	5.02	9.43	5.056	1.87	645	623
Lou II.....	17.35	6.95	10.40	5.135	2.03	885	870
Loula.....	18.31	6.41	11.90	5.293	2.25	802	816
Norabel.....	14.38	5.87	8.51	4.488	1.90	742	741
Pride III.....	15.31	6.41	8.90	4.536	1.96	805	813
Sweet C.....	17.19	6.65	10.54	5.375	1.96	842	838
Tricksey C.....	15.08	7.33	7.75	3.918	1.98	930	920
Trusty Lee.....	13.45	6.25	7.20	4.279	1.68	772	806
White.....	14.97	8.48	6.49	3.646	1.78	1,078	1,063
Average.....	15.95	6.85	9.10	4.741	1.92	864	866

Reducing the feed nutrients consumed and the milk solids yielded by each cow to common factors, and comparing the nutriment available for product with the product yielded, and noting the effect on the live weight, we have the figures embodied in Table 22.

From Table 22 it is seen that the nutriment consumed daily ranged from 13.45 to 18.81, and averaged 15.95 pounds, or at the rate of 18.44 pounds per 1,000 pounds live weight, while during the winter preceding it was 17.8. The average calculated food of maintenance was 6.85 pounds, and the average amount of net nutriment available for product was 9.1 pounds. The product yielded was 4.743 pounds, or 0.02 pound more than during the winter preceding. The cows returned, on an average, 1 pound of dairy product to 1.92 pounds of net nutriment, being 0.01 pound more than was required the preceding winter; and the cows weighed, on an average, 2 pounds more the last half of the experiment than they did the first half, while the winter previous they weighed 2 pounds less. A study of the table shows that of the 15.95 pounds of nutriment consumed daily, 4.743 pounds appeared in the milk solids, recovering 29.73 per cent; 70.27 per cent was used for maintenance, expended in the digestive processes, and in the slight gain in weight of cows.

THE WINTER OF 1908-1909

During the fall of 1908 the cows did not freshen as nearly at the same time as was desired. Belle and Maud were in milk when they came to the herd. The record covers a period of 24 weeks, with the following exceptions: Fanny 23, Clara 22, Maud 21, Fay 19, and Estella and Topsy II, 18 weeks each. Sweet C. was not in normal condition during the first half of the winter, but did fairly well during the latter half. The herd as a whole did excellent work, considering the fact that the cows were used more in class work than was the case in previous winters, as more time was given to dairy-stock judging.

This was the first winter when use was made of the tentative feeding standard in adjusting the quantity of feed to be given to various members of the herd, based upon the weight of the cow and the quantity and quality of milk she was giving, though more was fed to some of the cows with a view of getting them in better condition for work during the following winter. This was especially true in case of the Holsteins. The composition of the feed was not known until a year or so after the feeding was done, so the American average composition tables were employed in adjusting the grain mixture when stall feeding began. This, however, is a satisfactory method, as was clearly shown in Bulletin 79 of this Station. Indeed, if such were not the

case, there would be no practical use for such tables. The same is true with respect to tables giving the digestible nutrients in feeds.

The following grain mixture was fed during the winter: 4 parts bran, and 2 parts each of corn meal, barley meal, and oil meal. The roughage was choice upland prairie hay and corn silage. The silage supply was limited. There was only a small amount of roots, and these were given to the cows that seemed to need them most, and were fed only a few weeks. Table 23 shows the average amount of feed given to each cow per day, during the winter.

TABLE 23

AVERAGE AMOUNT OF FEED AND DRY MATTER CONSUMED PER DAY, DAYS IN TRIAL, AND AVERAGE LIVE WEIGHT

Cow	Grain	Hay	Silage	Roots	Dry Matter	Length of Trial	Live Weight
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Days	Lbs.
B. Belle II.	11.5	11.8	29.5	7.0	29.31	168	1,114
Clara.	11.9	11.3	25.3	.9	27.10	154	923
Cora.	10.9	10.0	20.7	....	23.84	168	925
Cylene.	10.0	11.9	30.2	....	27.67	168	1,128
Doretta.	10.0	11.9	32.2	....	28.07	168	1,117
Duchess P. P. ...	10.1	9.9	24.0	1.2	24.12	168	833
Estella.	8.4	8.0	16.9	....	18.78	126	623
Euroma.	10.7	9.1	24.0	.8	23.95	168	902
Fanny.	10.5	9.6	23.8	2.2	24.22	161	975
Fay.	7.8	9.5	19.9	....	20.32	133	887
Halo.	8.6	8.0	16.7	....	18.98	168	737
Houston II.	9.0	9.4	22.7	....	22.35	168	863
Lou II.	12.2	7.2	22.5	4.6	23.59	168	923
Loula.	7.6	9.9	19.9	4.2	21.27	168	817
Maude.	11.5	11.1	30.9	....	27.96	147	1,086
Nora P.	7.8	7.9	19.8	....	19.17	168	752
Norabel.	9.7	9.1	24.0	.8	23.64	168	782
Prudy.	9.4	7.5	22.7	.7	21.49	168	735
Sweet C.	8.5	10.2	24.2	....	23.06	168	947
Swiss.	7.9	11.7	31.4	....	25.71	168	1,243
Topsy II.	15.5	7.6	23.8	....	26.62	126	910
Tricksey C.	13.1	9.2	27.2	18.3	29.21	168	998
Trix.	6.6	9.7	29.7	.8	23.04	168	1,106
Tulip.	9.5	9.2	24.2	.8	23.64	168	989
White.	10.6	9.4	29.2	.8	26.07	168	1,081
Average.	10	9.6	24.6	1.7	24.13	162	936

From Table 23 it is seen that the cows received an average of 10 pounds of grain mixture, 9.6 pounds of hay, and 24.6 pounds of silage per day. The amount of roots given in the table is the amount the cows would have received if the total pounds consumed by each cow were divided by the days she was in the experiment. The cows received, daily, 24.13 pounds of dry matter, calculated upon the actual composition of the feed given. Dry matter was consumed at the rate of 25.8

pounds per 1,000 pounds live weight, while during the winter preceding it was at the rate of 27.6 pounds. The cows averaged 162 days in the experiment and 936 pounds in weight.

TABLE 24

AVERAGE POUNDS OF DIGESTIBLE NUTRIENTS FED AND DAIRY PRODUCTS YIELDED PER DAY

Cow	NUTRIENTS DAILY			DAILY PRODUCTION			
	Protein	Carbo- hydrates	Fat	Milk	Fat	Solids- Not- Fat	
	Lbs.	Lbs.	Lbs.	Lbs.	P. ct.	Lbs.	Lbs.
B. Belle II.	2.18	15.47	0.949	29.1	3.80	1.107	2.43
Clara.	2.18	14.07	.899	34.4	3.14	1.080	2.93
Cora.	1.96	12.35	.798	30.7	3.35	1.029	2.61
Cylene.	2.00	14.40	.911	29.6	3.07	.905	2.38
Doretta.	1.99	14.62	.927	31.3	3.36	1.052	2.54
Duchess P. P.	1.87	12.57	.805	25.6	5.17	1.320	2.28
Estella.	1.53	9.71	.622	20.8	5.02	1.047	1.89
Euroma.	1.93	12.51	.817	24.8	5.64	1.397	2.35
Fanny.	1.93	12.67	.807	28.0	2.93	.821	2.25
Fay.	1.52	10.48	.646	31.8	3.65	1.162	2.56
Halo.	1.54	9.84	.635	19.6	5.61	1.099	1.86
Houston II.	1.69	11.63	.744	21.5	4.99	1.070	1.94
Lou II.	2.06	12.56	.839	39.2	2.68	1.050	3.20
Loula.	1.50	11.19	.658	22.3	4.12	.918	1.92
Maude.	2.17	14.52	.937	30.4	3.40	1.035	2.46
Nora P.	1.46	9.97	.642	19.5	4.77	.932	1.80
Norabel.	1.81	12.37	.797	23.5	5.52	1.297	2.14
Prudy.	1.71	11.29	.747	18.7	5.38	1.008	1.73
Sweet C.	1.67	11.96	.753	19.0	4.38	.835	1.77
Swiss.	1.71	13.33	.820	18.3	4.82	.882	1.69
Topsy II.	2.53	13.94	.991	40.2	3.46	1.391	3.57
Tricksey C.	2.30	16.12	.959	33.3	4.86	1.620	3.01
Trix.	1.48	12.02	.741	18.6	4.81	.896	1.70
Tulip.	1.80	12.36	.794	20.9	5.65	1.180	1.93
White.	2.01	13.64	.891	27.0	4.51	1.215	2.43
Average.	1.86	12.62	.805	26.3	4.16	1.094	2.29

Topsy II and Tricksey C., old members of the herd, were in exceptionally good form, and did their best work. Topsy made up for her complete failure the winter preceding. The nutritive ratio of the ration was 1:7.7, while the winter before it was 1:8.1.

Reducing the nutrients consumed to a carbohydrate equivalent, by multiplying the ether extract by 2.2, adding the product to the carbohydrates and protein for total nutriment consumed daily, multiplying the daily average butter fat yielded by 2.25, and adding the product to the solids-not-fat for total product, we have the figures given in Table 25.

TABLE 25

AVERAGE TOTAL NUTRIMENT CONSUMED, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, PRODUCT YIELDED PER DAY, AND NET NUTRIMENT PER POUND OF PRODUCT

Cow	NUTRIMENT			TOTAL PRODUCT DAILY	NET NU- TRIMENT TO 1 LB. PRODUCT	WEIGHT	
	Total	Main- tenance	Prod- uct			Period	
						I	II
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
B. Belle II.....	19.74	8.82	10.92	4.921	2.22	1,100	1,127
Clara.....	18.23	7.31	10.92	5.360	2.04	920	927
Cora.....	16.07	7.33	8.74	4.925	1.77	922	927
Cylene.....	18.40	8.93	9.47	4.416	2.14	1,107	1,147
Doretta.....	18.65	8.85	9.80	4.907	2.00	1,107	1,126
Duchess P. P.....	16.21	6.60	9.61	5.250	1.83	847	820
Estella.....	12.61	4.93	7.68	4.246	1.81	636	611
Euroma.....	16.24	7.14	9.10	5.493	1.66	905	899
Fanny.....	16.37	7.72	8.65	4.097	2.11	960	991
Fay.....	13.42	7.02	6.40	5.174	1.24	904	867
Halo.....	12.78	5.84	6.94	4.333	1.60	735	740
Houston II.....	14.96	6.83	8.13	4.347	1.87	865	862
Lou II.....	16.47	7.31	9.16	5.562	1.65	947	899
Loula.....	14.14	6.47	7.67	3.985	1.92	809	825
Maude.....	18.75	8.60	10.15	4.789	2.12	1,076	1,097
Nora P.....	12.84	5.96	6.88	3.897	1.77	757	747
Norabel.....	15.93	6.19	9.74	5.058	1.93	770	793
Prudy.....	14.64	5.82	8.82	3.998	2.21	715	755
Sweet C.....	15.29	7.50	7.79	3.649	2.13	963	947
Swiss.....	16.84	9.84	7.00	3.674	1.90	1,221	1,265
Topsy II.....	18.65	7.21	11.44	6.700	1.71	909	912
Tricksey C.....	20.53	7.90	12.63	6.655	1.90	1,014	982
Trix.....	15.13	8.76	6.37	3.716	1.71	1,087	1,125
Tulip.....	15.91	7.83	8.08	4.585	1.76	968	1,010
White.....	17.61	8.56	9.05	5.164	1.75	1,076	1,086
Average.....	16.25	7.41	8.84	4.751	1.86	933	939

The cows consumed daily, on an average, 16.25 pounds of nutriment; 7.41 pounds is the calculated daily maintenance requirement of the body, leaving 8.84 pounds daily for the production of milk solids. Of the 8.84 pounds of net nutriment available for product, 4.751 pounds were found in the daily product. It required 1.86 pounds of net nutriment to produce 1 pound of product; that is, the 1 pound appeared in the product, and the 0.86 pound was expended in the processes of digestion, and in the slight gain in body weight indicated by the increase of the average live weight from 933 pounds during the earlier half of the winter to 939 pounds during the latter half.

Taking the 16.25 pounds of nutriment consumed daily, the average weight of the cows and the 4.751 pounds of product yielded as a basis, it appears that 45.57 per cent of the nutriment was applied to maintenance, 29.22 per cent appeared in the product, and 25.21 per cent was used for energy for mastication and digestion of the ration.

the slight gain in live weight, and such waste as may take place in the transference of the nutriment in the feed to milk solids.

There can be no absolute and fixed uniformity in results obtained in studies in nutrition, because of variation in the composition of feed and the net efficiency of nutriment arising from the varying condition of the feed from year to year. The great surprise is that, under the circumstances, the results are as uniform as they are. The decrease in the percentage of waste during the winter in review may be due to the attempt to adjust the ration to the needs of the cows by the tentative feeding standard referred to, and the narrower nutritive ration.

From an examination of the net nutriment required by the different cows to produce a pound of product, it will be seen that usually those using less than the average amount, 1.86 pounds, lost in body weight, while those that used more, gained. The grain mixture was adjusted to cows weighing 1,000 pounds and yielding 25 pounds of 4 per cent milk daily, and since there was a great variation in the size of the cows and the quantity and quality of milk yielded, the nutrients in the rations did not exactly meet the requirements of those whose size and yield of milk varied considerably from the basis upon which the grain mixture was made, and in such cases more waste occurred.

GENERAL SUMMARY AND STUDY OF RESULTS

TABLE 26

SUMMARY OF DRY MATTER AND DIGESTIBLE NUTRIENTS CONSUMED AND DAIRY PRODUCTS YIELDED DURING NINE WINTERS OF STALL FEEDING

Winter	Group	Dry Matter	Crude Protein	Carbohydrates	Ether Extract	Butter Fat	Solids-Not-Fat	Nutritive Ratio of Rations
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
1894-1895.....		24.40	2.00	12.46	0.56	1.069	2.09	1:6.8
1895-1896.....		23.91	2.59	12.24	.67	1.011	2.02	1:5.3
1902-1903.....	I	19.86	1.28	11.16	.46	.931	2.06	1:9.4
1902-1903.....	II	21.77	1.92	11.86	.48	1.048	2.21	1:6.7
1903-1904.....	I	19.68	1.32	11.04	.39	.996	2.10	1:9.0
1903-1904.....	II	20.65	1.97	10.99	.36	1.032	2.02	1:6.1
1904-1905.....	I	20.52	1.30	11.71	.50	.852	1.81	1:9.8
1904-1905.....	II	21.97	1.92	11.95	.50	1.030	2.11	1:6.8
1905-1906.....		21.86	1.63	12.55	.50	1.013	2.14	1:8.3
1906-1907.....		22.87	1.74	13.05	.63	1.068	2.26	1:8.3
1907-1908.....		23.89	1.75	12.78	.64	1.094	2.28	1:8.1
1908-1909.....		24.13	1.86	12.62	.80	1.094	2.29	1:7.7

From Table 26 it is seen that during the winter of 1894-1895, with a daily protein supply of 2 pounds, and a nutritive ratio of 1:6.8, there was obtained a greater yield of butter fat than during any winter fol-

lowing until the winters of 1907-1908 and 1908-1909. The period covered by the data was 154 days, and the members of the herd maintained their body weight. During the winter of 1895-1896 the daily average protein supply was 2.59 pounds and a nutritive ratio of 1:5.3, with a depression in the yield of butter fat and solids-not-fat, and an increase in the weight of the cows. At the close of the experiment the newly discovered tuberculin test was applied and the herd was reduced to about ten head. The lost animals were gradually replaced by the heifers and heifer calves that passed the test. In the autumn of 1901-1902 experimental work was resumed, and the results published in Bulletin 79. The data for the winter of 1901-1902 is not included in the summary because it covered only 56 days, and would not be comparable with experiments covering more than 150 days.

During the winter of 1902-1903 to 1904-1905 inclusive, the herd was divided into two groups. During the winter of 1902-1903 Group I received a daily protein supply of 1.28 pounds, with a nutritive ratio of 1:9.4 and yielded 0.931 pound of butter fat daily, while Group II received daily 1.92 pounds of protein with a nutritive ratio of 1:6.7, and yielded 1.048 pounds of butter fat. The period covered by this experiment averaged only 97 days, and therefore will not be included in the final summary.

During the winter of 1904-1905, Group I received daily 1.3 pounds of protein with a nutritive ratio of 1:9.0, and yielded daily 0.996 pound of butter fat, while Group II received daily 1.97 pounds of protein with a nutritive ratio of 1:6.1 and yielded 1.032 pounds of butter fat.

During the winter of 1904-1905, Group I received daily 1.30 pounds of protein giving the ration a nutritive ratio of 1:9.8 and during 19 weeks yielded a daily average of 0.852 pound of butter fat. The ration was then increased so as to furnish a daily protein supply of 1.87 pounds and with a nutritive ratio of 1:6.6 yielded daily 0.822 pound of butter fat and made rapid gain in live weight. Group II during 26 weeks received a protein supply of 1.92 pounds, giving the ration a nutritive ratio of 1:6.8, and yielded 1.03 pounds of butter fat per day.

During the winter of 1905-1906 the herd received a protein supply of 1.63 pounds, giving the ration a nutritive ratio of 1:8.3, and yielded 1.013 pounds of butter fat per day, while during the winter following the protein supply was 1.74 pounds, the nutritive ratio 1:8.3 and the average daily yield of butter fat 1.068 pounds, or practically the amount yielded during the winter 1894-1895, and with an increase of 0.17 pound of solids-not-fat.

During the winter of 1907-1908, it was the purpose to provide 1.8

pounds of protein daily, but because of an unexpected depression in the protein content of some of the feed, the daily supply was only 1.75 pounds of protein, giving the ration a nutritive ratio of 1:8.1, with a daily yield of 1.094 pounds of butter fat.

For the winter of 1908-1909 it was planned to provide a ration containing 1.85 pounds of protein, but the daily supply was 1.86 pounds with a nutritive ratio of 1:7.7 and the daily yield of butter fat was 1.094 pounds, exactly the yield secured the winter preceding.

Table 27 was arranged by eliminating the data for the three groups with low-protein rations, and converting the average nutrients consumed per day each winter to nutriment. This was done by multiplying the ether extract in the rations by 2.2, adding the product to the carbohydrates and protein in the rations, multiplying the butter fat yielded daily by 2.25, adding the solids-not-fat to obtain the total product, and calculating the nutriment used for body maintenance, the net nutriment per unit of product, and the weights of the herd.

TABLE 27

SUMMARY OF AVERAGE LIVE WEIGHT, NUTRIMENT DAILY, TOTAL FOR MAINTENANCE, FOR PRODUCT AND IN PRODUCT YIELDED; NET NUTRIMENT PER POUND OF PRODUCT; AND WEIGHT OF COWS

WINTER	LIVE WEIGHT	NUTRIMENT			TOTAL PRODUCT DAILY	NET NUTRIMENT TO 1 LB. PRODUCT	WEIGHT		
		Total	Main-tenance	Prod-uct			Period		
							I	II	Average
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
1894-1895...	956	15.69	7.57	8.13	4.49	1.81	954	958	956
1895-1896...	976	16.30	7.75	8.55	4.295	1.99	.....	.....	976
1902-1903...	880	14.84	6.96	7.88	4.576	1.72	882	878	880
1903-1904...	907	13.74	7.18	6.56	4.341	1.51	900	913	907
1904-1905...	901	14.98	7.14	7.84	4.427	1.77	896	905	901
1905-1906...	864	15.27	6.85	8.43	4.425	1.90	868	861	864
1906-1907...	907	16.18	7.19	8.99	4.663	1.92	908	906	907
1907-1908...	865	15.95	6.85	9.10	4.741	1.92	864	866	865
1908-1909...	936	16.25	7.41	8.84	4.751	1.86	933	939	936
Average...	910	15.47	7.20	8.27	4.523	1.83	901	903	910
Average without 1902-1903...	914	15.55	7.24	8.31	4.517	1.84	903	907	914

Table 27 shows that during the nine winters of experimental feeding, the average weight per cow ranged from 864 to 976 pounds, and averaged 910 pounds, and that the average of nutriment consumed daily ranged from 13.74 to 16.30, and averaged 15.47 pounds. After deducting the nutriment calculated for maintenance of body, that left for milk-production ranged from 6.55 to 9.1, and averaged 8.27 pounds;

that the average daily product yielded per cow ranged 4.295 to 4.751 and averaged 4.523 pounds and the net nutriment used to a pound of product ranged from 1.51 to 1.99, averaging 1.83 pounds. The average of the weights, omitting that for 1895-1896, is 901 pounds for the first half and 903 for the last half of the winter. The smallest yield in milk solids was during the winter of 1895-1896, when the daily average was 4.295 pounds. The exceptional amount of nutriment charged to a pound of product, 1.99, during the winter of 1895-1896 was due to the fact that part was diverted to gain in weight at the rate of 0.2 pound per day during Period II.¹ The exceptionally small amount used during the winter of 1903-1904 is due, at least in part, to the fact that more roots were fed than during any other winter, and possibly to light feeding and a narrower nutritive ratio. The large yield, 4.576 pounds for the winter of 1902-1903, was due to the fact that it covered a period of only 97 days while the others range from 157 to 191 days. For this reason an average is given which omits the work of that winter.

Heavy feeding, as a rule, causes more waste than light feeding. It appears that during the last four winters more net nutriment was consumed to a pound of product yielded. It also appears that during the last four winters a larger yield was obtained but it does not show the relation of the feed to the size of the cows. Table 28 throws some light on this phase of the subject.

TABLE 28

AVERAGE AMOUNT OF NUTRIMENT CONSUMED AND DAIRY PRODUCTS YIELDED PER 1,000 POUNDS LIVE WEIGHT

WINTER	NUTRIMENT			TOTAL PRODUCT	NET NUTRIMENT PER LB. OF PRODUCT	NUTRITIVE RATIO
	Total	Maintenance	Product			
1894-1895.....	Lbs. 16.41	Lbs. 7.92	Lbs. 8.49	Lbs. 4.696	Lbs. 1.81	1:6.8
1895-1896.....	16.70	7.92	8.78	4.401	1.99	1:5.3
1903-1904.....	15.15	7.92	7.23	4.786	1.51	1:6.1
1904-1905.....	16.64	7.92	8.72	4.913	1.77	1:6.8
1905-1906.....	17.67	7.92	9.75	5.121	1.91	1:8.3
1906-1907.....	17.84	7.92	9.92	5.141	1.91	1:8.3
1907-1908.....	18.44	7.92	10.52	5.481	1.92	1:8.1
1908-1909.....	17.39	7.92	9.35	5.076	1.86	1:7.7
Average.....	17.03	7.92	9.11	4.952	1.84	1:7.0

Table 28 shows that the average amount per day of nutriment consumed per 1,000 pounds live weight ranged from 15.15 to 18.44 pounds, and averaged for the eight winters 17.03 pounds. After deducting the amount calculated for maintenance, that which remained available for

¹ Haecker, T. L., *Investigations in Milk Production*, Minn. Exp. Sta. Bull. 79, p. 50.

product ranged from 7.23 to 10.52 pounds and averaged 9.11 pounds. Of this there appeared in the milk solids, yields ranging from 4.401 to 5.481 pounds and averaging 4.952 pounds. The net nutriment consumed per pound of dairy products yielded, ranged from 1.51 to 1.99 pounds. The lower figure was obtained when the rations contained roots most generously for the longest period. The higher figures resulted when the cows made unusual gains in live weight, thus diverting some of the nutriment charged to the dairy products to body fat. The two unusual results were left in the table as an offset, since their average does not vary materially from that of the other two of the first four years. The average net nutriment per pound of product was 1.84; that is, for each 1.84 pounds of net nutriment consumed, 1 pound appeared in the form of milk solids.

TABLE 29

AVERAGE TOTAL NUTRIMENT CONSUMED, NUTRIMENT FOR MAINTENANCE, NUTRIMENT FOR PRODUCT, AND PRODUCT YIELDED PER DAY, NET NUTRIMENT PER POUND OF PRODUCT, AND NUTRITIVE RATIO OF RATIONS PER 1,000 POUNDS LIVE WEIGHT

WINTER	NUTRIMENT				NET NUTRIMENT PER LB. OF PRODUCT	NUTRITIVE RATIO
	Total	For Maintenance	For Product	In Product		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
1894-1895.....	16.41	7.92	8.49	4.696	1.81	1:6.8
1895-1896.....	16.70	7.92	8.78	4.401	1.99	1:5.3
1893-1904.....	15.15	7.92	7.21	4.786	1.51	1:6.1
1904-1905.....	16.64	7.92	8.72	4.913	1.77	1:6.8
Average I.....	16.22	7.92	8.30	4.699	1.77	1:6.2
Per cent.....	100	48.77	51.23	28.98		
1905-1906.....	17.67	7.92	9.75	5.121	1.91	1:8.3
1906-1907.....	17.84	7.92	9.92	5.141	1.91	1:8.3
1907-1908.....	18.44	7.92	10.52	5.481	1.92	1:8.1
1908-1909.....	17.39	7.92	9.35	5.076	1.86	1:7.7
Average II.....	17.83	7.92	9.91	5.205	1.90	1:8.1
Per cent.....	100	44.42	55.58	29.19		
Average I.....	16.22	7.92	8.30	4.699	1.77	1:6.2
Average II.....	17.83	7.92	9.91	5.205	1.90	1:8.1
Average.....	17.02	7.92	9.10	4.952	1.84	1:7.0
Per cent.....	100	46.48	53.52	29.08		

During the four winters in Period I the cows received 16.24 pounds of nutriment per day with a nutritive ratio of 1:6.2, and returned an average daily product of 4.682 pounds, being 1 pound of

product to 1.78 pounds of net nutriment. There appeared in the product 28.83 per cent of the nutriment, and 71.17 per cent was expended in maintenance of body and for energy used in the digestive processes and wastes in the transference of digestible components in food to milk solids.

During the four winters in Period II the cows received 17.83 pounds of nutriment daily with a nutritive ratio of 1:8.1 and returned an average daily product of 5.205 pounds, being 1 pound of product to 1.9 pounds of net nutriment. There appeared in the product 29.19 per cent of the nutriment while 70.81 per cent was expended for body maintenance, for energy to carry on the digestive processes, and as waste in the transference of the digestible matter in the feed to milk solids.

During the eight winters the cows consumed 17.5 pounds of digestible matter daily, and returned 4.955 pounds in equivalent milk solids, being 29.1 per cent of the nutriment, leaving 12.095 pounds or 70.9 per cent for maintenance, energy, and waste. One pound of product was returned to 1.84 pounds of net nutriment, with an average nutritive ratio of 1:7.0.

TABLE 30

VARIATION IN NUTRIMENT CONSUMED, PRODUCTS YIELDED, PERCENTAGE IN PRODUCT, AND EXPENDED FOR MAINTENANCE, ENERGY, AND WASTE PER 1,000 POUNDS LIVE WEIGHT

Winter	Nutriment Daily	Product Daily	Returned in Product	Expended in Maintenance, Energy, and Waste
	Lbs.	Lbs.	P. ct.	P. ct.
1903-1904.....	15.15	4.786	31.59	68.41
1894-1895.....	16.41	4.696	28.62	71.38
1904-1905.....	16.64	4.913	29.52	70.48
1908-1909.....	17.39	5.076	29.19	70.81
1905-1906.....	17.67	5.121	28.98	71.02
1906-1907.....	17.84	5.141	28.82	71.18
1907-1908.....	18.44	5.481	29.72	70.28
Average.....	17.08	5.031	29.49	70.51

In Table 30 the data are arranged on the basis of the average amount of nutriment consumed daily during the winters when an equilibrium in body weight of the herd was maintained and when the experimental feeding covered periods ranging from 162 to 196 days. The daily average nutriment consumed ranges from 15.15 to 18.44, and the average for the 7 winters was 17.08 pounds. The daily average product yielded ranged from 4.693 to 5.481, and averaged 5.031 pounds

of water-free milk solids. In a general way the product returned was proportionate to the nutriment consumed except during the first two winters, when a greater product was returned from 15.15 pounds of nutriment than from 16.41 pounds. This may be due to the fact that more roots were fed and for a longer period during the winter of 1903-1904 than any other winter, and the data from five heifers with first calf are included in the record for the winter of 1894-1895. These two exceptional conditions are also reflected in the percentage returned in product, that for the first year given in the table is 31.59, the largest return during the seven winters, while in the second it is 23.62, the smallest return. The percentages returned in product during the other years are remarkably uniform, the greatest variation being only 0.9 of one per cent. The average percentage in product for the seven years was 29.49. The last column shows that the average amount expended for body maintenance, energy, and waste in converting feed nutrients to milk solids, ranged from 68.41 to 71.38 per cent and averaged 70.51 per cent. The minimum and maximum used for maintenance, energy, and waste occurred during the first two years given in the table, doubtless caused by the exceptional conditions previously referred to. The ration fed during the winter of 1903-1904 had a greater net nutritive value because it contained more roots, requiring less energy for maintenance and the digestive process and consequently leaving relatively more for product. On the other hand, the nutriment used for growth by the five heifers during the winter of 1894-1895 could not be regarded as for product and is included in the last column. The results are remarkably uniform and show the efficiency of the dairy cow in converting feed into food for mankind.

COMPOSITION OF MILK AND RELATION OF FEED NUTRIENTS TO MILK SOLIDS

During the time when the feeding experiments in milk-production in review were in progress, it occurred to the writer that in order to determine the actual net nutrients required to produce a given animal product, the composition of the product should be known, as well as the composition and the available nutrients in food which is to be fed for its production, so that the nutrients in the ration might be provided in the proportions needed by the animal. Before a builder bids on a contract, he determines the quantity needed of each of the materials that are to appear in the structure. Without such specifications he would not know how much of each of the different materials would have to be provided.

We learned, through the agency of the Babcock milk test, the

amount of butter fat contained in milk of various grades and the chemist could determine by gravimetric analysis the various components in milk, but apparently it had never occurred to him to divide milk into specific grades and determine the average composition of each, at least no such table was known to the writer. This seemed especially strange, since for nearly half a century protein requirements in feeding for milk-production have been the chief problem.

This matter was presented in January, 1903, to Professor Harry Snyder, Chief of the Division of Agricultural Chemistry and Soils, and through his kind offices arrangements were made for the analysis of composite samples of milk from the different cows used in the feeding experiment. This work was continued to the close of the year 1907.

It has been shown that there was a remarkable uniformity in the net nutriment required for the production of a unit of milk solids when nutrients consumed and milk solids produced were reduced to carbohydrate equivalent. The milk solids are composed of butter fat and solids-not-fat. The organic solids other than fat are sugar and protein. In Bulletin 79 of this Station, published in January, 1903, it was clearly shown that cows need net nutriment in their rations proportionate to the quality of the milk as measured by the fat content. It also appeared that the richer the milk in fat, the more net protein was consumed per unit of milk produced. Whether this was merely incidental because more nutriment was required as milk increased in fat percentage, or whether more protein was required because there was more protein in the richer milk, did not appear because the relation of protein to fat in the various grades of milk was not known. As the protein content of the food of maintenance was adjusted to the needs of the animal for the maintenance of the body, so must the protein in the production part of the ration be adjusted to the protein content of the milk. In order to make such adjustment possible, it was necessary to find the protein content of milk of the various grades as measured by the fat content, by making a gravimetric analysis of a large number of samples of milk and grouping them in specific grades. It was also necessary to determine the average composition of the samples of the various groups instead of finding the average composition of all samples of milk analyzed as had been the custom.

During the years 1904 and 1905 the number of samples that could be taken care of by the Division of Agricultural Chemistry and Soils was limited because of lack of sufficient help, but during the two years following a special analyst was employed for this work, and samples from ten cows were generally taken each week. At first the dry matter, ash, fat, and nitrogen, were determined by gravimetric analyses and sugar found by difference. During the last two years the average

of the fourteen fat determinations, made by the Babcock test of each milking, was used and only determinations of total solids, nitrogen, and ash were made by the chemist.

The milk was divided into 10 grades. That testing under 2.75 per cent fat was put into the 2.5 grade, from 2.75 to 3.25 into the 3 per cent grade, from 3.25 to 3.75 into the 3.5 grade, from 3.75 to 4.25 into 4 per cent grade and so on to the 7 per cent grade. By this method a sample did not vary more than a quarter of 1 per cent from the average of its class.

TABLE 31

A. SUMMARY OF ORGANIC COMPOSITION OF MILK AND RELATION OF SOLIDS

NUMBER OF		COMPOSITION			CARBOHYDRATE EQUIVALENT	NUTRITIVE RATIO	FAT TO SOLIDS-NOT-FAT
Samples	Milkings	Fat	Protein	Carbohydrates			
		P. ct.	P. ct.	P. ct.	P. ct.		
47	658	2.5	2.55	4.45	12.62	1:3.95	1:2.80
55	770	3.0	2.68	4.60	14.03	1:4.23	1:2.43
57	798	3.5	2.81	4.75	15.43	1:4.49	1:2.16
57	798	4.0	3.08	4.85	16.93	1:4.49	1:1.97
116	1,624	4.5	3.27	4.97	18.36	1:4.62	1:1.83
103	1,442	5.0	3.45	4.99	19.68	1:4.70	1:1.68
89	1,246	5.5	3.65	4.92	20.94	1:4.74	1:1.56
39	546	6.0	3.82	4.91	22.23	1:4.82	1:1.45
24	336	6.5	4.02	4.90	23.54	1:4.85	1:1.37
13	182	7.0	4.22	4.84	24.81	1:4.88	1:1.29

B. PERCENTAGE COMPOSITION OF WATER-FREE SUBSTANCE IN MILK OF VARYING GRADES OF FAT CONTENT

Grade of Milk	Butter Fat	Protein	Carbohydrates	Ash
P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
3.0 fat	27.27	24.36	41.83	6.54
3.5 "	29.76	23.89	40.40	5.95
4.0 "	31.70	24.40	38.45	5.46
4.5 "	33.41	24.28	36.89	5.42
5.0 "	35.28	24.35	35.22	5.15
5.5 "	37.16	24.66	33.25	4.93
6.0 "	38.78	24.69	31.75	4.78
6.5 "	39.95	25.32	30.12	4.61
7.0 "	41.62	25.09	28.78	4.51

Table 31 is based on analyses of 544 samples taken from 7,616 milkings. There were so few samples containing less than 2.5 per cent butter fat, and so many more testing from 2.5 to 2.75, that no satisfactory average could be obtained for milk testing 2.5 per cent butter fat, so the averages were computed from the ratio of variation of milk testing from 3 to 3.5 per cent fat.

It will be seen that as milk increases in fat content it also increases

in protein content, but not at the same rate. While milk testing 5 per cent butter fat contains twice as much fat as 2.5 per cent milk, it does not contain twice as much protein. In a general way, an increase of .5 per cent in fat is followed by an increase of 0.02 per cent in protein, showing that rations must be adjusted to the protein content of the milk, as well as to quantity of milk. The sugar content of milk increases from 4.60 per cent in milk testing 3 per cent fat to 4.98 per cent in 5-per-cent milk, and then gradually decreases to 4.84 per cent in 7-per-cent milk. The carbohydrate equivalents of the total solids of the different grades of milk range from 14.03 for 3-per-cent milk, to 24.81 for 7-per-cent milk. The nutritive ratio of the various grades of milk ranges from 1:4.23 for milk testing 3 per cent fat to 1:4.88 for milk testing 7 per cent fat. The last column shows the relation of fat to solids-not-fat. In 3-per-cent milk there are 2.43 pounds of solids-not-fat to 1 pound of butter fat; and in 6-per-cent milk, 1 pound of fat to 1.45 pounds not fat, indicating that butter fat only is not a logical basis for feeding for milk-production. From a study of the table it appears that there is a slight depression in the protein content of milk testing 3.5 per cent butter fat, and also that there is an abnormal rise in the protein content of milk averaging 6.5 per cent butter fat. It appears that it should be 4.02 instead of 4.12. This is also indicated by the nutritive ratio.

The samples of milk taken from cows while on low-protein rations are not included in Table 31, giving the organic composition of milk and relation of the solids, because of the depression of milk solids as shown by Table 32.

TABLE 32

AVERAGE COMPOSITION OF MILK PRODUCED BY COWS WHEN ON A LOW-PROTEIN RATION AND WHEN ON A MEDIUM-PROTEIN RATION

Low-Protein Ration						
Cow	MILK-INGS	PERCENTAGE COMPOSITION OF MILK				
		Solids	Fat	Protein	Carbo- hydrate	Ash
Euroma.....	84	14.18	5.14	3.28	5.03	0.73
Leeoma.....	84	14.20	5.04	3.33	5.06	.77
Lou.....	112	10.14	2.55	2.63	4.20	.76
Sweet C.....	84	13.14	4.27	2.93	5.23	.71
Swiss.....	84	13.52	4.43	3.19	5.17	.73
Topsy.....	84	11.96	3.50	2.88	4.87	.71
Tricksey C.....	98	12.97	4.38	2.89	5.00	.70
White.....	84	13.30	4.64	3.04	4.93	.69
Average.....		12.92	4.24	3.02	4.94	.72
Per cent.....		100	32.8	23.4	38.2	5.6

TABLE 32—Continued

Medium-Protein Ration						
Cow	MILK- INGS	PERCENTAGE COMPOSITION OF MILK				
		Solids	Fat	Protein	Carbo- hydrate	Ash
Euroma	98	14.86	5.51	3.45	5.17	.73
Leeoma	112	16.64	6.40	4.54	4.92	.78
Lou	140	11.06	2.99	2.70	4.64	.73
Sweet C	168	13.45	4.30	3.38	5.05	.72
Swiss	280	13.88	4.72	3.51	4.90	.75
Topsy	56	12.46	3.86	2.92	4.99	.69
Tricksey C	224	13.95	4.84	3.42	4.97	.72
White	196	13.71	4.76	3.26	4.96	.73
Average		13.75	4.67	3.40	4.95	.73
Per cent		100	34.0	24.7	36.0	5.3

It is shown that without exception the cows gave milk containing a lower percentage of solids when fed a ration containing a nutritive ratio of 1:9.4 than they did when receiving rations ranging in nutritive ratio from 1:6 to 1:8.3 and when on pasture. There was also a depression in both fat and protein in every case. Taking the total solids as a basis the fat is lowered 1.2 per cent and the protein 1.3 per cent and the milk sugar or carbohydrate raised 2.2 and the ash raised 0.3 per cent, thus offsetting the depression in fat and protein.

RELATION OF PROTEIN IN FEED TO PROTEIN IN MILK

No tables have been submitted showing the relation of the daily net crude protein available for milk-production to the daily protein content in the milk and to the total daily product yielded. Tables 33 and 34 provide this data. During the first four years the nutritive ratio of the rations averaged 1:6.2 and during the last four years 1:8.1.

TABLE 33

AVERAGE WEIGHT PER COW, POUNDS OF DIGESTIBLE CRUDE PROTEIN CONSUMED, AND PRODUCTS YIELDED PER DAY

Year	Weight	Protein	Milk	Fat		Solids- Not- Fat
				P. ct.	Lbs.	Lbs.
1894-1895	956	2.00	26.1	4.10	1,069	2.09
1902-1903	879	1.92	25.2	4.16	1,050	2.21
1903-1904	908	1.97	22.6	4.57	1,032	2.02
1904-1905	895	1.92	24.3	4.24	1,030	2.11
Average	909	1.95	24.5	4.26	1,045	2.11
1905-1906	864	1.63	24.7	4.11	1,013	2.145
1906-1907	907	1.74	25.3	4.22	1,068	2.26
1907-1908	865	1.75	26.0	4.21	1,094	2.28
1908-1909	936	1.86	26.3	4.16	1,094	2.29
Average	893	1.74	25.6	4.17	1,067	2.244\$

During the first four years the daily protein supply was 1.95 pounds with a daily yield of 24.5 pounds of milk containing 1.045 pounds of butter fat and 2.11 pounds of solids-not-fat, while during the last four years the daily protein supply was 1.745 pounds with a daily average yield of 25.6 pounds of milk containing 1.067 pounds of butter fat and 2.244 pounds of solids-not-fat.

TABLE 34

DAILY AVERAGE POUNDS OF DIGESTIBLE CRUDE PROTEIN CONSUMED, PROTEIN FOR MAINTENANCE, PROTEIN AVAILABLE FOR MILK-PRODUCTION, PROTEIN CONTENT OF MILK, NET CRUDE PROTEIN TO 1 POUND OF MILK PROTEIN, TOTAL PRODUCT, AND PRODUCT PER 100 POUNDS LIVE WEIGHT

YEAR	CRUDE PROTEIN			PROTEIN IN MILK	NET CRUDE PROTEIN TO 1 LB. PROTEIN IN MILK	TOTAL PRODUCT DAILY	PRODUCT PER 100 LBS. LIVE WEIGHT
	In Feed	For Main- tenance	For Milk				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1894-1895.....	2.00	0.67	1.33	0.814	1.63	4.495	
1902-1903.....	1.92	.62	1.30	.793	1.64	4.572	
1903-1904.....	1.97	.64	1.33	.747	1.78	4.342	
1904-1905.....	1.92	.63	1.29	.769	1.68	4.428	
Average.....	1.95	.64	1.31	.781	1.68	4.462	0.49
1905-1906.....	1.63	.60	1.03	.772	1.33	4.427	
1906-1907.....	1.74	.64	1.10	.803	1.37	4.663	
1907-1908.....	1.75	.61	1.14	.823	1.38	4.741	
1908-1909.....	1.86	.66	1.20	.828	1.45	4.752	
Average.....	1.74	.63	1.11	.806	1.38	4.645	.52

In examining the results secured during the first four years, as measured by the total product daily, it will be seen that there was a slight increase for the winter of 1902-1903 and a decrease in 1903-1904. This is accounted for by the fact that in the former the data cover 97 and in the latter 196 days. The average time covered for the first four years was 155 days and for the last four, 164 days. The data for the winter of 1905-1906 include that of some of the cows that were on the low protein for four winters preceding, which may have a bearing on the relatively low yield of total product per day during that winter.

Of the 1.95 pounds daily protein supply during the first four years, 0.64 pound is the protein calculated for maintenance, leaving 1.31 pounds available for milk-production. The daily average protein content in the milk was 0.781 pound, being a return of 1 pound of milk protein to 1.68 pounds of net crude protein in the ration,

with a yield of 4.462 pounds of total product in milk solids reduced to a common factor.

During the last four years there was a daily supply of 1.74 pounds of crude protein with calculated protein requirements for maintenance of 0.63 of a pound, leaving 1.11 pounds available for milk-production. The daily average protein content in the milk, 0.806 pound, being a return of 1 pound of milk protein to 1.38 pounds of net crude protein in the ration, with a daily yield of 4.645 pounds of total product in milk solids.

It appears from these results that an allowance in the daily ration of 1.5 units of crude protein to 1 unit of protein in the milk would be ample under the conditions that obtained in the Station herd. In view of the fact that all reproductive processes in the living body are stimulated and nourished by the nitrogenous properties in the feed and that there is considerable variation in the composition of feed and in milks having the same per cent of fat content, and since the feeds ordinarily fed to cows are not as uniform or of as fine quality as that used in these experiments, and that cows are ordinarily not provided with as comfortable quarters and handled with the care and strict regularity as was the case with the Station herd, 1.75 units of net crude protein is prescribed for 1 unit of protein in the milk. In 1 pound of milk testing 4 per cent there is on an average 0.0308 pound of protein and for its production there is prescribed 0.0539 pound crude protein. The carbohydrates prescribed for the production of a pound of milk bear the same relation to the non-nitrogenous components in the milk, being 1.75 to 1, while the ether extract prescribed for 1 pound of milk is 15 per cent of the non-nitrogenous components in the milk. The sum of the nutrients prescribed for the production of a pound of milk reduced to a carbohydrate equivalent is 2.02 times the sum of the milk solids in a pound of milk reduced to a carbohydrate equivalent. Ether extract in feed is regarded as 2.2 times as valuable as carbohydrates, while milk fat is given a rating of 2.25. The non-nitrogenous nutrients are not reduced to common terms in the tables because of the great variation in the nutritive value of ether extract and because they are generally given separately in tables of digestible nutrients.

In the first subdivision of Table 35 the first of the four columns gives the grades of milk based upon fat content for each one-tenth of one per cent increase in butter fat for milk testing from 2.5 per cent of fat to 7 per cent. The second column gives the pounds of protein in each grade, the third column gives the pounds of milk sugar and the fourth gives the pounds of water-free solids reduced

TABLE 35

COMPOSITION OF MILK FOR EACH 0.1 PER CENT INCREASE IN PERCENTAGE OF FAT, TOTAL SOLIDS, NITROGENOUS AND NON-NITROGENOUS COMPONENTS IN 1 POUND OF EACH GRADE AND THE NET NUTRIMENT PRESCRIBED FOR PRODUCTION

ORGANIC SOLIDS			SOLIDS IN C. H. EQUIVA- LENT	COMPONENTS IN 1 LB. OF MILK IN C. H. EQUIVALENT		NET NUTRIENTS FOR THE PRODUCTION OF 1 LB. OF MILK		
Fat	Protein	Carbo- hydrates		Nitrogen- ous	Non- Nitrogen- ous	Pro- tein	Carbo- hydrates	Ether Extract
P. ct.	P. ct.	P. ct.	P. ct.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
2.5	2.55	4.45	12.62	0.0255	0.1007	0.0446	0.176	0.0151
2.6	2.58	4.48	12.91	.0258	.1033	.0451	.180	.0155
2.7	2.60	4.51	13.18	.0260	.1058	.0455	.185	.0159
2.8	2.63	4.54	13.47	.0263	.1084	.0460	.190	.0163
2.9	2.65	4.57	13.74	.0265	.1109	.0464	.194	.0166
3.0	2.68	4.60	14.03	.0268	.1135	.0469	.199	.0170
3.1	2.71	4.63	14.31	.0271	.1160	.0474	.203	.0174
3.2	2.73	4.66	14.59	.0273	.1186	.0478	.207	.0178
3.3	2.76	4.69	14.87	.0276	.1211	.0483	.212	.0181
3.4	2.78	4.72	15.15	.0278	.1237	.0486	.216	.0185
3.5	2.81	4.75	15.43	.0281	.1262	.0492	.221	.0189
3.6	2.86	4.77	15.73	.0286	.1287	.0501	.225	.0193
3.7	2.92	4.79	16.03	.0292	.1311	.0511	.229	.0196
3.8	2.97	4.81	16.33	.0297	.1336	.0520	.234	.0200
3.9	3.03	4.83	16.63	.0303	.1360	.0530	.238	.0204
4.0	3.08	4.85	16.93	.0308	.1385	.0539	.242	.0208
4.1	3.12	4.87	17.21	.0312	.1409	.0546	.247	.0211
4.2	3.16	4.90	17.51	.0316	.1435	.0553	.251	.0215
4.3	3.19	4.92	17.78	.0319	.1459	.0558	.255	.0218
4.4	3.23	4.95	18.08	.0323	.1485	.0565	.260	.0222
4.5	3.27	4.97	18.36	.0327	.1509	.0572	.264	.0226
4.6	3.31	4.97	18.63	.0331	.1532	.0579	.268	.0230
4.7	3.34	4.97	18.88	.0334	.1554	.0584	.272	.0233
4.8	3.38	4.97	19.15	.0338	.1577	.0591	.276	.0236
4.9	3.41	4.98	19.41	.0341	.1600	.0597	.280	.0240
5.0	3.45	4.98	19.68	.0345	.1623	.0604	.284	.0243
5.1	3.49	4.97	19.93	.0349	.1644	.0611	.288	.0247
5.2	3.53	4.96	20.19	.0353	.1666	.0618	.291	.0250
5.3	3.57	4.94	20.43	.0357	.1686	.0625	.295	.0253
5.4	3.61	4.93	20.69	.0361	.1708	.0632	.299	.0256
5.5	3.65	4.92	20.94	.0365	.1729	.0639	.302	.0259
5.6	3.68	4.92	21.20	.0368	.1752	.0644	.307	.0263
5.7	3.72	4.92	21.46	.0372	.1774	.0651	.310	.0266
5.8	3.75	4.91	21.71	.0375	.1796	.0656	.314	.0269
5.9	3.79	4.91	21.97	.0379	.1818	.0663	.318	.0273
6.0	3.82	4.91	22.23	.0382	.1841	.0668	.322	.0276
6.1	3.88	4.91	22.51	.0388	.1863	.0679	.326	.0279
6.2	3.94	4.91	22.80	.0394	.1886	.0689	.330	.0283
6.3	4.00	4.90	23.07	.0400	.1907	.0700	.334	.0286
6.4	4.06	4.90	23.36	.0406	.1930	.0710	.338	.0289
6.5	4.12	4.90	23.64	.0412	.1952	.0721	.342	.0293
6.6	4.14	4.89	23.88	.0414	.1974	.0724	.345	.0296
6.7	4.16	4.88	24.11	.0416	.1995	.0728	.349	.0299
6.8	4.18	4.86	24.34	.0418	.2016	.0731	.353	.0302
6.9	4.20	4.85	24.57	.0420	.2037	.0735	.357	.0305
7.0	4.22	4.84	24.81	.0422	.2057	.0738	.359	.0308

to a carbohydrate equivalent in 100 pounds of milk of the various grades.

In the second subdivision the first column gives the fraction of a pound of protein in one pound of milk of each grade, and the second column, the non-nitrogenous substances in one pound of milk expressed in carbohydrate equivalent.

The three columns in the third subdivision constitute the feeding standard for milk-production, giving the net digestible crude protein, carbohydrates, and ether extract prescribed for the production of 1 pound of milk of the various grades ranging from that testing 2.5 per cent to that testing 7 per cent butter fat. The standard for body maintenance is 0.07 pound of crude protein, 0.7 pound of carbohydrates, and 0.01 pound of ether extract per 100 pounds live weight.

APPLICATION OF THE STANDARD

Multiplying the nutrients prescribed for the production of 1 pound of milk of a given grade by the number of pounds of milk yielded per day, gives the nutrients required daily for the production of the milk. To this must be added the nutrients required daily for food of maintenance. To illustrate, let it be assumed that a cow weighing 1,000 pounds yields daily 24 pounds of milk, testing 4.5 per cent butter fat. Multiplying the nutrients prescribed for the production of one pound of milk testing 4.5 per cent butter fat by 24, and adding to this the nutrients required per day for the food of maintenance gives the nutrients required in the daily ration.

TABLE 36

NUTRIENTS FOR A 1,000-POUND COW GIVING 24 POUNDS OF 4.5-PER-CENT MILK

		Pro- tein	Carbo- hydrates	Fat
	Lbs.	Lbs.	Lbs.	Lbs.
For milk testing 4.5 per cent fat	24	1.37	6.34	0.54
For maintenance	1,000	.70	7.00	.10
Nutrients required		2.07	13.34	.64

Roughage is usually fed according to the size of a cow, and concentrates according to the production of milk. The grain mixture is adjusted to the kind of roughage to be fed and the quantity to be fed is governed by the average yield and quality of the milk.

Cows generally eat hay at the rate of 2 pounds per day per hundred weight. It takes three pounds of silage to equal one pound

of hay or drilled fodder corn cut as fine as silage, but a pound of dry matter in roots is regarded as equal to a pound of dry matter in grain. The grain mixture is adapted to the available roughage and in adjusting the grain mixture preference is given to farm grains followed by their by-products. In accordance with these general directions, and employing the American tables of average composition and digestibility of feeds, except silage, which is based upon analyses made at the Minnesota Experiment Station, illustrations are submitted showing how grain mixtures may be adjusted to the roughage to be fed and to the quantity and quality of milk yielded.

TABLE 37
RATION FOR A 1,000-POUND COW YIELDING 24 POUNDS OF 4.5-PER-CENT MILK

Feed	Quantity	Crude Protein	Carbo-hydrates	Ether Extract
	Lbs.	Lbs.	Lbs.	Lbs.
Timothy hay.....	10	0.28	4.34	0.14
Corn silage.....	30	.37	4.26	.21
In roughage.....		.65	8.60	.35
Corn, ground.....	2	.158	1.33	.086
Barley, ground.....	1	.084	.65	.016
Oats, ground.....	1	.107	.50	.038
Flour middlings.....	3	.507	1.61	.123
Linseed meal.....	2	.604	.64	.138
Nutrients provided.....		2.11	13.33	.75
Nutrients required.....		2.07	13.34	.64

From Table 37 it is seen that by making a grain mixture composed of 2 parts each of corn and linseed meal, 1 part each of barley and oats, and 3 parts wheat flour middlings, we provide the nutrients needed for feeding with timothy and corn silage and that in this case 9 pounds of the grain mixture is needed to balance the ration.

In order to determine conveniently the amount of the grain mixture needed by cows giving various grades and quantities of milk, a table is made giving the nutrients contained in from 1 to 10 pounds of the mixture.

TABLE 38
GRAIN MIXTURE A TO SUPPLEMENT TIMOTHY HAY AND CORN SILAGE

GRAIN	QUANTITY	COMPOSITION		
		Pro-tein	Carbo-hydrates	Ether Extract
	Lbs.	Lbs.	Lbs.	Lbs.
Corn, ground.....	2	0.158	1.33	0.086
Barley, ground.....	1	.084	.65	.016
Oats, ground.....	1	.107	.50	.038
Flour middlings.....	3	.507	1.61	.123
Linseed meal.....	2	.604	.64	.138
Total.....	9	1.46	4.73	.401

TABLE 38—Continued

GRAIN	QUANTITY	COMPOSITION		
		Protein	Carbo-hydrates	Ether Extract
	Lbs.	Lbs.	Lbs.	Lbs.
Mixture.....	1	.162	.5255	.0445
Mixture.....	2	.324	1.051	.089
Mixture.....	3	.487	1.576	.133
Mixture.....	4	.649	2.102	.178
Mixture.....	5	.811	2.627	.222
Mixture.....	6	.973	3.153	.267
Mixture.....	7	1.135	3.678	.311
Mixture.....	8	1.298	4.204	.356
Mixture.....	9	1.460	4.729	.401
Mixture.....	10	1.622	5.255	.445

Since the difference in the nutritive ratio between milk testing 3 per cent fat and that testing 7 per cent fat is only 0.65, and since the nutrients in the productive part of the feeding standard are proportioned to the solids in the various grades of milk, a ration balanced for the production of milk testing 4.5 per cent butter fat is also approximately balanced for all grades of milk ordinarily found in dairy herds.

TABLE 39

RATIONS FOR COWS WEIGHING FROM 800 TO 1,400 POUNDS AND GIVING MILK OF SPECIFIED QUANTITY AND QUALITY

	Total Feed	Protein	Carbo-hydrates	Fat	Total Nutrient
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,400-Pound Cow, Giving 50 Pounds of 3-Per-Cent Milk					
In timothy hay.....	14	0.39	6.08	.19	.....
In corn silage.....	40	.50	5.68	.28	.....
In roughage.....	.....	.89	11.76	.47	.....
In grain mixture A.....	15	2.43	7.88	.67	.....
Nutrients provided.....	.....	3.32	19.64	1.14	25.45
Nutrients required.....	.....	3.32	19.75	.99	25.25
Ration for a 1,200-Pound Cow, Giving 40 Pounds of 3.5-Per-Cent Milk					
Timothy hay.....	12	.34	5.21	.17	.....
Corn silage.....	36	.45	5.11	.25	.....
In roughage.....	.....	.79	10.32	.42	.....
In grain mixture A.....	12.5	2.03	6.57	.56	.....
Nutrients provided.....	.....	2.82	16.89	.98	21.87
Nutrients required.....	.....	2.81	17.24	.88	21.99

TABLE 39—Continued

	Total Feed	Protein	Carbohy- drates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,000-Pound Cow, Giving 30 Pounds of 4-Per-Cent Milk					
Timothy hay.....	10	0.28	4.34	0.14	.....
Corn silage.....	30	.37	4.26	.21	.....
In roughage.....	.....	.65	8.60	.35	.....
Grain mixture A.....	10.5	1.70	5.52	.47	.....
Nutrients provided.....	.....	2.35	14.12	.82	18.27
Nutrients required.....	.....	2.32	14.26	.72	18.16
Ration for a 900-Pound Cow, Giving 24 Pounds of 5-Per-Cent Milk					
Timothy hay.....	9	0.25	3.91	0.13	.....
Corn silage.....	27	.34	3.83	.19	.....
In roughage.....	.....	.59	7.74	.32	.....
Grain mixture A.....	10	1.62	5.25	.44	.....
Nutrients provided.....	.....	2.21	12.99	.76	16.87
Nutrients required.....	.....	2.08	13.12	.67	16.67
Ration for an 800-Pound Cow, Giving 20 Pounds of 6-Per-Cent Milk					
Timothy hay.....	8	.22	3.47	.11	.....
Corn silage.....	24	.30	3.41	.17	.....
In roughage.....	.....	.52	6.88	.28	.....
In grain mixture A.....	9.5	1.54	4.99	.42	.....
Nutrients provided.....	.....	2.06	11.87	.70	15.47
Nutrients required.....	.....	1.90	12.04	.63	15.33

The illustrations in Table 39 show how rations can be adjusted to meet the needs of large and small cows yielding milk of various quantities and grades when timothy or wild hay and corn silage constitute the roughage to be fed. Many other mixtures can be made which will meet the requirements as well as the one given as an illustration. Table 40 is given to show how a grain mixture may be adjusted to the use of clover hay and silage for roughage.

TABLE 40
GRAIN MIXTURE B TO SUPPLEMENT CLOVER HAY AND ENSILAGE

	Total Feed	Protein	Carbohy- drates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,000-Pound Cow, Giving 24 Pounds of 4.5 Per Cent Milk					
For milk.....	24	1.37	6.34	0.54	.....
For maintenance.....	1,000	.70	7.00	.10	.....
Nutrients required.....	.....	2.07	13.34	.64	16.82

TABLE 40—Continued

	Total Feed	Protein	Carbo- hydrate	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Clover hay.....	10	.71	3.78	.18	.....
Corn silage.....	30	.37	4.26	.21	.....
In roughage.....	.....	1.08	8.04	.39	.....
Barley.....	3	.252	1.959	.048	.....
Corn.....	3	.237	2.001	.129	.....
Oats.....	2	.214	1.006	.076	.....
Linseed meal.....	1	.302	.320	.069	.....
Nutrients provided.....	.....	2.085	13.326	.712	16.98

From Table 40 it is seen that when clover and silage are fed a grain mixture composed of 3 parts barley, 3 parts corn, 2 parts oats, and 1 part linseed meal, will provide nutrients in approximately the right proportion.

By making a table showing the nutrients contained in from 1 to 10 pounds of the mixture, the pounds of grain required for various grades and quantities of milk can be quickly determined.

TABLE 41

RATIONS FOR COWS WEIGHING FROM 800 TO 1,400 POUNDS AND GIVING MILK OF SPECIFIED QUANTITY AND QUALITY
RATION FOR A 1,000-POUND COW, GIVING 24 POUNDS OF 4.5-PER-CENT MILK

	Total Feed	Protein	Carbo- hydrates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,400-Pound Cow, Giving 50 Pounds of 3-Per-Cent Milk					
Clover hay.....	14	0.99	5.29	0.25	.....
Corn silage.....	42	.52	5.96	.30	.....
In roughage.....	.....	1.51	11.25	.55	.....
In grain mixture B.....	15	1.67	8.81	.54	.....
Nutrients provided.....	.....	3.18	20.06	1.09	25.64
Nutrients required.....	.....	3.32	19.75	.99	25.25
Ration for a 1,200-Pound Cow, Giving 40 Pounds of 3.5-Per-Cent Milk					
Clover hay.....	12	.852	4.536	.216	.....
Corn silage.....	36	.446	5.112	.252	.....
In roughage.....	.....	1.30	9.65	.47	.....
In grain mixture B.....	13	1.45	7.63	.46	.....
Nutrients provided.....	.....	2.75	17.28	.93	22.08
Nutrients required.....	.....	2.81	17.24	.88	21.99

TABLE 41—Continued

	Total Feed	Protein	Carbo- hydrates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 900-Pound Cow, Giving 24 Pounds of 5-Per-Cent Milk					
Clover hay.....	9	.64	3.40	.16	.....
Corn silage.....	27	.34	3.83	.19	.....
In roughage.....	.....	.98	7.23	.35	.....
In grain mixture B.....	10	1.12	5.87	.36	.....
Nutrients provided.....	.....	2.10	13.10	.71	16.76
Nutrients required.....	.....	2.08	13.12	.67	16.67
Ration for an 800-Pound Cow, Giving 20 Pounds of 6-Per-Cent Milk					
Clover hay.....	8	.57	3.02	.14	.....
Corn silage.....	24	.30	3.41	.17	.....
In roughage.....	.....	.87	6.54	.31	.....
In grain mixture B.....	9.5	1.06	5.58	.34	.....
Nutrients provided.....	.....	1.93	12.01	.65	15.37
Nutrients required.....	.....	1.90	12.04	.63	15.33

As a further illustration, a grain mixture (C) to supplement roughage composed of alfalfa hay and corn silage will be made with equal parts of ground corn, barley, and oats and adjusted to cows of various sizes, yielding milk varying in quantity and quality.

TABLE 42

RATIONS FOR COWS WEIGHING FROM 800 TO 1,400 POUNDS AND GIVING MILK OF
SPECIFIED QUANTITY AND QUALITY
GRAIN MIXTURE C TO SUPPLEMENT ALFALFA AND CORN SILAGE

	Total Feed	Protein	Carbo- hydrates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,400-Pound Cow, Giving 50 Pounds of 3-Per-Cent Milk					
Alfalfa hay.....	14	1.64	5.73	0.14	.....
Corn silage.....	42	0.52	5.96	.30	.....
In roughage.....	.....	2.16	11.69	.44	.....
In grain mixture C.....	14	1.26	8.51	.45	.....
Nutrients provided.....	.....	3.42	20.20	.89	25.48
Nutrients required.....	.....	3.32	19.75	.99	25.25

TABLE 42—Continued

	Total Feed	Protein	Carbo- hydrates	Fat	Total Nutri- ment
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration for a 1,200-Pound Cow, Giving 40 Pounds of 3.5-Per-Cent Milk					
Alfalfa hay.....	12	1.40	4.91	.12	.....
Corn silage.....	36	.45	5.11	.25	.....
In roughage.....		1.85	10.02	.37	.....
In grain mixture C.....	12	1.08	7.29	.39	.....
Nutrients provided.....		2.93	17.31	.76	21.91
Nutrients required.....		2.81	17.24	.87	21.99
Ration for a 1,000-Pound Cow, Giving 30 Pounds of 4-Per-Cent Milk					
Alfalfa hay.....	10	1.17	4.09	.10	.....
Corn Silage.....	30	.37	4.26	.21	.....
In roughage.....		1.54	8.35	.31	.....
In grain mixture C.....	10	.90	6.08	.32	.....
Nutrients provided.....		2.44	14.43	.63	18.26
Nutrients required.....		2.32	14.26	.72	18.16
Ration for an 800-Pound Cow, Giving 20 Pounds of 6-Per-Cent Milk					
Alfalfa hay.....	8	.94	3.27	.08	.....
Corn silage.....	24	.30	3.41	.17	.....
In roughage.....		1.24	6.68	.25	.....
In grain mixture C.....	9	.81	5.47	.29	.....
Nutrients provided.....		2.05	12.15	.54	15.39
Nutrients required.....		1.90	12.04	.63	15.33

APPENDIX I

COWS USED IN EXPERIMENT

Name	Age	Breeding	Calved	Remarks	
1902-1903					
Betty C.	7	Guernsey	June 4, 1902	Bought Oct. 28, 1902 Was in milk.	
Cylene.	2	Holstein			
Dora F.	9	Holstein	Dec. 5, 1902	Aborted—farrow	
Duchess P. P. . . .	6	Jersey	Sept. 9, 1902		
Fay.	4	Holstein	Oct. 22, 1902		
Houston II.	7	Jersey-Guernsey	Oct. 24, 1902		
Klondike.	9	Jersey-Holstein	April 5, 1901		
L'Etoile.	13	Jersey	Nov. 28, 1902		
Lou II.	6	Holstein	Aug. 30, 1902		
Nora P.	8	Grade Jersey	Aug. 16, 1902		
Pride III.	7	Jersey	Dec. 7, 1902		
Rose C.	4	Ayeshire	Oct. 22, 1902		
Rose L.	4	Grade Shorthorn		Bought Oct. 10, 1902 Was in milk.	
Shorty.	11	Native	Aug. 29, 1902	Bought Oct. 10, 1902 Was in milk.	
Topsy II.	7	Jersey-Holstein	Nov. 22, 1902		
Tricksey C.	6	Guernsey	Nov. 21, 1902		
Trust.	7	Jersey	Jan. 7, 1903		
Trusty Lee.	3	Jersey	Nov. 7, 1902		
White.	3	Grade Shorthorn			
1903-1904					
Betty C.	5	Guernsey	Aug. 11, 1903		Aborted
Cylene.	3	Holstein	July 21, 1903		
Dora F.	10	Holstein	Sept. 30, 1903		Aborted—farrow Failed to breed.
Duchess P. P. . . .	7	Jersey	Aug. 31, 1903		
Fay.	5	Holstein	Dec. 24, 1903		
Houston II.	8	Jersey-Guernsey	Nov. 13, 1903		
Klondike.	10	Jersey-Holstein	April 5, 1901		
L'Etoile.	14	Jersey	Nov. 28, 1902		
Leeoma.	6	Jersey	Sept. 19, 1903		
Lou II.	7	Holstein	Sept. 30, 1903		
Nora P.	9	Grade Jersey	Sept. 30, 1903		
Pride III.	8	Jersey	Oct. 9, 1903		
Shorty.	12	Native	July 27, 1903		
Star II.	3	Grade Jersey	Aug. 10, 1903	Aborted	
Sweet C.	5	Guernsey	Aug. 16, 1903		
Topsy II.	8	Jersey-Holstein	Sept. 27, 1903		
Tricksey C.	7	Guernsey	Oct. 24, 1903		
Trust.	8	Jersey	Jan. 14, 1904		
Trusty Lee.	4	Jersey	June 24, 1903		
White.	4	Grade Shorthorn	Aug. 23, 1903		
1904-1905					
Betty C.	6	Guernsey	Oct. 6, 1904		Farrow
Dora F.	11	Holstein	Oct. 5, 1904		
Duchess P. P. . . .	8	Jersey	Sept. 6, 1904	Aborted—farrow	
Euroma.	7	Jersey	Dec. 5, 1903		
Fay.	6	Holstein	Dec. 17, 1904		
Houston II.	9	Jersey-Guernsey	Dec. 2, 1904		
Klondike.	11	Jersey-Holstein	April 5, 1901		
Leeoma.	7	Jersey	Dec. 4, 1904		
Lou II.	8	Holstein	Oct. 4, 1904		
Nora P.	10	Grade Jersey	Sept. 12, 1904		
Pride III.	9	Jersey	Sept. 25, 1904		

COWS USED IN EXPERIMENT—Continued

Name	Age	Breed	Calved	Remarks
1904-1905	Yrs.			
Star II.....	4	Grade Jersey	Nov. 14, 1904	
Sweet C.....	6	Guernsey	Oct. 29, 1904	
Swiss.....	3	Brown Swiss	Oct. 24, 1904	Bought Sept. 7, 1902
Topsy II.....	9	Jersey-Holstein	Sept. 16, 1904	
Tricksey C.....	8	Guernsey	Sept. 29, 1904	
Trust.....	9	Jersey	Nov. 15, 1904	
Trusty Lee.....	6	Jersey	Sept. 3, 1904	
White.....	5	Grade Shorthorn	Oct. 10, 1904	
1905-1906				
Cylene.....	5	Holstein	Sept. 28, 1905	
Doretta.....	2	Holstein	Jan. 10, 1906	
Duchess P. P....	9	Jersey	Aug. 28, 1905	
Euroma.....	8	Jersey	June 12, 1905	
Faith.....	3	Holstein	Nov. 5, 1905	
Fay.....	7	Holstein	Dec. 26, 1905	
Houston II.....	10	Jersey-Guernsey	Nov. 21, 1905	
Leeoma.....	8	Jersey	Aug. 13, 1905	Aborted
Letta P.....	4	Jersey	Nov. 24, 1905	
Lou II.....	9	Holstein	Oct. 26, 1905	
Nora P.....	11	Grade Jersey	Oct. 9, 1905	
Pride III.....	10	Jersey	Sept. 8, 1905	
Sweet C.....	7	Guernsey	Sept. 28, 1905	
Topsy II.....	10	Jersey-Holstein	Oct. 8, 1905	
Tricksey C.....	9	Guernsey	Aug. 21, 1905	
Trusty Lee.....	7	Jersey	Aug. 24, 1905	
White.....	6	Grade Shorthorn	Aug. 28, 1905	
1906-1907				
Alzanka.....	5	Grade Jersey	Feb. 14, 1906	
Cylene.....	6	Holstein	Sept. 18, 1906	
Daisy.....	2	Jersey	Oct. 19, 1906	Calf died.
Dora F.....	13	Holstein	Oct. 25, 1906	
Doretta.....	3	Holstein	Dec. 9, 1906	
Duchess P. P....	10	Jersey	Nov. 4, 1906	
Euroma.....	9	Jersey	Dec. 7, 1906	
Faith.....	4	Holstein	Oct. 28, 1906	
Fay.....	8	Holstein	Nov. 30, 1906	
Helen.....	3	Jersey-Guernsey	June 15, 1906	
Houston II.....	11	Jersey-Guernsey	Nov. 23, 1906	Aborted
Letta P.....	5	Jersey	Dec. 8, 1907	Farrow
Lola.....	2	Holstein	Aug. 3, 1906	Aborted
Lou II.....	10	Holstein	Sept. 10, 1906	
Loula.....	3	Holstein-Jersey	April 30, 1906	
Norabel.....	3	Grade Jersey	April 28, 1906	
Pride III.....	11	Jersey	Nov. 7, 1906	
Sweet C.....	8	Guernsey	Oct. 29, 1906	
Topsy II.....	11	Jersey-Holstein	Oct. 4, 1906	
Tricksey C.....	10	Guernsey	Sept. 6, 1906	
Trust.....	11	Jersey	Feb. 25, 1907	Aborted twins
Trusty.....	5	Jersey	Sept. 29, 1906	
Trusty Lee.....	8	Jersey	Nov. 9, 1906	
White.....	7	Grade Shorthorn	Sept. 16, 1906	
1907-1908				
Cylene.....	7	Holstein	Aug. 23, 1907	
Doretta.....	4	Holstein	Oct. 12, 1907	
Duchess P. P....	11	Jersey	Oct. 18, 1907	
Easter.....	3	Jersey	Dec. 13, 1907	
Euroma.....	10	Jersey	Nov. 27, 1907	

COWS USED IN EXPERIMENT—Continued

Name	Age	Breed	Calved	Remarks
1907-1908				
Fay	9	Holstein	Nov. 13, 1907	Aborted
Hazel	5	Jersey-Guernsey	Aug. 17, 1907	
Helen	4	Jersey-Guernsey	Oct. 21, 1907	
Letta P.	6	Jersey	Dec. 8, 1907	
Lou II.	11	Holstein	Sept. 24, 1907	
Loula	4	Holstein-Jersey	Sept. 20, 1907	
Norabel	4	Grade Jersey	Aug. 22, 1907	
Pride III.	12	Jersey	Oct. 15, 1907	
Sweet C.	9	Guernsey	Dec. 23, 1907	
Tricksey C.	10	Guernsey	Aug. 16, 1907	
Trusty Lee.	9	Jersey	Nov. 5, 1907	
White	8	Grade Shorthorn	Aug. 22, 1907	
1908-1909				
B. Belle II.	8	Holstein		Bought Nov. 7, 1908
Clara	3	Holstein	Dec. 16, 1908	Aborted
Cora	3	Holstein	Nov. 27, 1908	
Cylene	8	Holstein	Sept. 8, 1908	
Doretta	5	Holstein	Sept. 3, 1908	
Duchess P. P.	12	Jersey	Nov. 7, 1908	
Estella	3	Jersey	Jan. 8, 1909	
Euroma	11	Jersey	Nov. 14, 1908	
Fanny	12	Holstein	Dec. 10, 1908	
Fay	10	Holstein	Jan. 8, 1909	
Halo	3	Jersey-Guernsey	Nov. 22, 1908	
Helen	5	Jersey-Guernsey	Sept. 3, 1908	
Houston II.	13	Jersey-Guernsey	Sept. 6, 1908	
Lou II.	12	Holstein	Dec. 1, 1908	
Loula	5	Holstein-Jersey	Sept. 22, 1908	
Maude	6	Holstein		Bought Dec. 29, 1908
Nora P.	14	Grade Jersey	Oct. 25, 1908	Milk fever
Norabel	5	Grade Jersey	Sept. 16, 1908	
Prudy				
Sweet C.	10	Guernsey	Jan. 11, 1909	
Topsy II.	13	Jersey-Holstein	Jan. 14, 1909	
Tricksey C.	11	Guernsey	Oct. 17, 1908	
Trix				
Trusty Lee.	10	Jersey	Sept. 15, 1908	
Tulip	4	Jersey	Aug. 29, 1908	
White	8	Grade Shorthorn	Nov. 15, 1908	

APPENDIX II

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1902-1903

FEED	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN FREE EXTRACT	DIGESTIBLE		
						Protein	Carbohydrates	Ether Extract
Corn	P. ct. 87.85	P. ct. 10.30	P. ct. 3.58	P. ct. 1.94	P. ct. 70.70	P. ct. 6.18	P. ct. 66.72	P. ct. 3.08
Barley	90.12	12.22	2.10	6.72	66.40	8.55	64.45	1.87
Oats	91.35	11.03	3.42	9.12	64.03	8.60	50.48	2.84
Oil meal	89.18	34.40	7.13	8.16	34.64	30.62	31.67	6.34

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1902-1903—Continued

FEED	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN FREE EXTRACT	DIGESTIBLE		
						Protein	Carbohydrates	Ether Extract
	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Bran.....	87.39	15.01	4.05	9.27	52.66	12.01	39.08	3.08
Middlings.....	89.07	18.08	6.03	4.65	18.08	14.82	17.04	5.12
Gluten meal.....	90.11	37.45	1.27	1.48	40.36	33.33	38.36	1.18
Prairie hay.....	89.56	7.31	3.41	32.14	40.44	3.43	42.64	1.63
Timothy.....	89.17	6.19	2.92	32.79	42.44	2.97	43.79	1.66
Corn silage.....	19.02	1.57	.52	5.13	10.64	.82	10.52	.35
Roots (Mangels).....	9.10					1.10	5.40	.099

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1903-1904

Corn.....	89.10	9.33	3.95	3.22	71.35	5.60	67.96	3.40
Oats.....	90.15	9.51	4.94	15.73	55.72	7.42	45.50	4.10
Barley.....	90.12	12.22	2.10	6.72	67.40	8.55	65.37	1.87
Gluten meal.....	90.11	37.45	1.27	1.48	40.36	33.33	38.36	1.18
Oil meal.....	91.76	32.95	9.30	9.96	34.46	29.32	32.55	8.27
Roots.....	10.80	1.22	0.07	1.61	6.68	.94	7.00	.00
Prairie hay.....	90.64	5.93	2.70	34.61	40.24	2.78	44.04	1.29
Silage.....	21.51	2.04	0.28	7.71	9.90	1.06	11.61	.19
Fodder corn.....	86.04	7.74	1.87	31.46	38.01	4.80	46.67	1.23

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1904-1905

Corn.....	85.69	9.06	3.53	2.59	68.96	6.16	66.80	3.27
Barley.....	84.21	10.56	1.74	6.82	62.63	7.39	61.03	1.55
Oats.....	86.23	9.85	3.46	10.35	59.46	7.68	47.14	2.87
Oil meal.....	90.64	29.60	11.70	8.32	46.22	26.34	40.79	10.41
Gluten feed.....	90.74	25.45	2.99	8.95	50.56	21.89	52.06	2.51
Prairie hay.....	90.97	8.02	2.25	29.74	43.12	3.84	42.70	1.08
Corn silage.....	21.44	1.71	0.49	6.24	11.41	.89	11.74	.42

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1905-1906

Mixture Figures Show Proportions		Dry Matter	Crude Protein	Carbohydrates	Ether Extract
		P. ct.	P. ct.	P. ct.	P. ct.
No. 1					
Corn 2	Bran 4	0.8991	0.1179	0.4590	0.0248
Barley 2	Oil meal 1				
Oats 2	Gluten feed 1				
No. 2					
Corn 2	Oil meal 1	.8981	.1239	.5083	.0294
Barley 2	Gluten feed 1				
Bran 4					
No. 3					
Corn 3	Bran 4	.8955	.1068	.5261	.0296
Barley 2	Oil meal 1				
Prairie hay.....		.908	.0299	.5370	.0126
Corn silage.....		.2119	.0104	.1155	.0041
Mangels.....		.075	.0110	.0420	.0007

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1906-1907

FEED	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN FREE EXTRACT	DIGESTIBLE		
						Protein	Carbohydrates	Ether Extract
Corn.....	P. ct. 91.26	P. ct. 9.35	P. ct. 4.15	P. ct. 1.87	P. ct. 74.59	P. ct. 6.36	P. ct. 71.79	P. ct. 3.82
Barley.....	91.31	11.09	2.05	5.45	69.63	7.76	66.78	1.82
Bran.....	91.14	14.54	4.84	11.22	54.08	11.30	40.56	3.29
Oil meal.....	90.86	31.86	8.91	9.30	35.77	28.35	33.20	7.93
Gluten feed..	90.83	22.65	3.30	7.24	55.77	19.48	55.27	2.77
Prairie hay...	90.70	6.10	3.53	30.11	42.31	2.93	42.48	1.69
Silage.....	25.70	2.01	6.81	5.92	15.46	1.04	14.34	.58
Fodder corn..	70.40	6.51	2.20	14.06	42.48	3.25	37.03	1.65
Roots.....	7.50	1.41	.14	.86	4.61	1.10	4.20	.07

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1907-1908

FEED	PERIOD	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN FREE EXTRACT	DIGESTIBLE		
							Protein	Carbohydrates	Ether Extract
Oil meal.	I	P. ct. 90.02	P. ct. 32.06	P. ct. 8.57	P. ct. 7.54	P. ct. 38.25	P. ct. 28.65	P. ct. 34.14	P. ct. 7.63
Oil meal.	II	92.42	32.10	8.03	8.81	38.64	28.57	35.16	7.15
Bran....	I	91.20	14.43	4.46	12.26	53.96	11.54	40.71	3.39
Bran....	II	89.63	14.39	4.58	12.22	52.16	11.51	39.44	3.48
Corn....	I	87.88	9.24	3.60	1.99	71.36	5.55	67.35	3.09
Corn....	II	82.38	8.82	2.55	1.96	67.72	5.29	63.96	2.19
Barley...	I	87.94	10.87	1.22	5.28	67.82	7.61	65.02	1.09
Barley...	II	87.47	10.72	1.61	5.19	66.98	7.51	64.21	1.43
Silage...	I	32.39	2.63	1.13	8.05	18.23	1.37	17.57	.96
Silage...	II	24.61	1.80	.60	6.78	13.32	.94	13.39	.51
Prairie hay...	I	89.75	6.52	3.29	27.79	45.51	3.06	42.89	1.57
Prairie hay...	II	87.61	6.23	2.26	27.63	44.56	2.92	42.25	1.08
Roots...	I	12.01	1.08	.017	.087	11.19	.83	10.79	.008

COMPOSITION OF FEEDS AS DETERMINED BY THE DIVISION OF AGRICULTURAL CHEMISTRY, 1908-1909

Barley...	I	87.71	10.92	1.92	5.32	67.03	7.64	64.32	1.71
Barley...	II	87.31	11.17	2.21	5.25	66.01	7.82	63.36	1.96
Corn....	I	87.66	8.94	3.78	2.42	71.16	5.36	67.38	3.25
Corn....	II	85.15	8.71	4.32	1.99	68.74	5.23	64.92	3.71
Oil meal.	I	91.43	33.58	8.12	7.10	37.29	29.88	33.14	7.23
Oil meal.	II	91.14	34.46	8.44	7.30	35.80	30.58	28.75	7.52
Bran....	I	88.51	13.96	5.08	10.43	52.68	11.16	39.38	3.86
Bran....	II	88.27	14.29	5.14	11.28	51.47	11.44	38.74	3.90
Prairie hay...	I	86.04	5.42	2.54	27.68	42.57	2.54	41.15	1.22
Prairie hay...	II	85.38	6.51	2.34	27.67	41.85	3.06	40.74	1.12
Silage...	I	29.15	2.21	1.54	7.48	16.46	1.14	15.98	1.31
Silage...	II	27.04	1.90	1.26	7.46	15.09	.99	14.90	1.07
Fodder Corn..	II	71.50	5.10	2.04	25.32	34.47	3.06	40.70	1.51

APPENDIX III

COMPOSITION OF MILK AS DETERMINED BY THE DIVISION OF AGRICULTURAL
CHEMISTRY

MILK AVERAGING 3 PER CENT FAT
RANGE FROM 2.75 TO 3.25 PER CENT FAT

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Lou.....	Feb. 16, 1904	2.77	2.16	4.71	0.68	10.32
Lou II.....	Dec. 17, 1905	2.78	2.39	4.99	.74	10.90
Dora F.....	Dec. 3, 1905	2.80	2.77	4.10	.70	10.37
Lou II.....	Jan. 21, 1906	2.81	2.49	4.45	.75	10.50
Lou.....	Oct. 28, 1906	2.83	2.48	4.48	.75	10.54
Lou.....	Oct. 13, 1907	2.83	2.98	4.71	.79	11.31
Dora F.....	Dec. 2, 1906	2.83	2.53	4.50	.70	10.56
Dora F.....	Nov. 11, 1906	2.84	2.80	4.75	.64	11.03
Dora F.....	Feb. 2, 1905	2.86	2.60	4.60	.72	10.78
Dora F.....	Jan. 7, 1906	2.87	2.75	4.33	.65	10.60
Lou II.....	Feb. 18, 1906	2.87	2.55	4.46	.75	10.63
Cylene.....	Oct. 13, 1907	2.90	2.93	4.72	.70	11.25
Lou.....	Nov. 19, 1905	2.90	2.67	4.75	.77	11.09
Lou.....	Dec. 23, 1906	2.91	2.66	4.30	.74	10.61
Lou.....	March 17, 1907	2.93	2.72	4.59	.74	10.98
Lou II.....	Feb. 18, 1906	2.93	2.40	4.75	.75	10.83
Dora F.....	March 5, 1906	2.97	2.58	4.18	.69	10.42
Cylene.....	Oct. 14, 1906	2.97	2.75	4.51	.68	10.91
Dora F.....	Feb. 4, 1906	2.98	2.75	4.04	.81	10.58
Cylene.....	Jan. 7, 1906	2.98	2.61	4.91	.69	11.19
Fancy.....	Nov. 3, 1907	2.98	2.96	4.59	.75	11.28
Dora F.....	Nov. 14, 1904	3.00	2.61	4.48	.72	10.81
Dora F.....	Dec. 23, 1906	3.00	2.46	4.48	.71	10.65
Doretta.....	Nov. 3, 1907	3.02	2.92	4.51	.72	11.17
Lou II.....	Dec. 17, 1905	3.02	2.33	4.85	.69	10.89
Dora F.....	Jan. 16, 1905	3.02	2.78	4.23	.72	10.75
Cylene.....	Oct. 28, 1906	3.02	2.74	4.41	.69	10.86
Lou.....	April 21, 1907	3.03	2.80	4.70	.73	11.26
Topsy.....	Oct. 21, 1906	3.03	3.18	4.66	.69	11.56
Lou.....	Jan. 13, 1907	3.04	2.58	4.63	.73	10.98
Lou.....	Feb. 24, 1907	3.05	2.76	4.67	.78	11.26
Cylene.....	Nov. 11, 1906	3.05	2.84	4.43	.62	10.94
Cylene.....	Dec. 3, 1905	3.05	2.63	4.58	.73	10.99
Lou.....	Nov. 11, 1906	3.06	2.53	4.89	.67	11.15
Doretta.....	Nov. 24, 1907	3.07	2.50	4.97	.71	11.25
Dora F.....	Nov. 16, 1903	3.09	2.49	4.46	.70	10.74
Lou.....	Oct. 21, 1906	3.10	2.54	4.83	.72	11.19
Cylene.....	March 5, 1906	3.11	2.59	4.84	.69	11.23
Dora F.....	Feb. 3, 1907	3.12	3.12	4.31	.68	11.23
Doretta.....	Nov. 10, 1907	3.13	2.70	4.77	.71	11.31
Lou.....	April 8, 1907	3.14	2.92	4.63	.69	11.38
Dora F.....	Feb. 24, 1907	3.17	2.75	4.38	.78	11.08
Lou II.....	Nov. 19, 1905	3.20	2.60	4.93	.78	11.51
Lola.....	Dec. 9, 1906	3.22	2.54	5.04	.68	11.48
Faith.....	Dec. 17, 1905	3.23	2.44	4.97	.70	11.34
Cylene.....	Dec. 16, 1906	3.24	3.13	4.53	.74	11.64
Cylene.....	Nov. 25, 1906	3.25	2.93	4.66	.68	11.52
(47)	Total.....	141.00	125.94	216.26	33.65	516.85
	Average.....	3.00	2.68	4.60	.72	11.00

COMPOSITION OF MILK AVERAGING 3.5 PER CENT FAT
RANGE FROM 3.25 TO 3.75 PER CENT FAT

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Topsy.....	Oct. 28, 1906	3.28	3.23	4.93	0.70	12.14
Fay.....	Feb. 18, 1906	3.28	2.38	4.63	.66	10.95
Doretta.....	Oct. 27, 1907	3.28	3.04	4.42	.84	11.58
Rose H.....	Dec. 1, 1903	3.28	2.77	5.33	.71	12.09
Doretta.....	Jan. 27, 1907	3.29	2.70	4.80	.69	11.48
Cylene.....	Jan. 6, 1907	3.30	2.95	4.57	.76	11.58
Dora F.....	March 17, 1907	3.30	2.82	4.39	.75	11.26
Dora F.....	Jan. 12, 1904	3.31	2.47	4.48	.67	10.93
Cylene.....	Jan. 27, 1907	3.36	3.08	4.61	.71	11.76
Doretta.....	July 28, 1907	3.39	3.02	4.63	.67	11.71
Fancy.....	Nov. 10, 1907	3.39	2.74	4.42	.86	11.41
Doretta.....	March 10, 1907	3.40	2.68	4.98	.65	11.71
Lola.....	Jan. 20, 1907	3.41	2.63	4.99	.69	11.72
Doretta.....	March 31, 1907	3.42	2.68	4.82	.64	11.56
Dora F.....	Feb. 9, 1904	3.43	2.75	4.82	.68	11.68
Reddy.....	Feb. 16, 1904	3.43	2.93	4.63	.72	11.71
Faith.....	Feb. 17, 1907	3.44	2.69	4.66	.73	11.52
Faith.....	Jan. 27, 1907	3.44	2.61	4.72	.68	11.45
Fay.....	Dec. 3, 1905	3.45	2.62	4.94	.60	11.61
Loula.....	Oct. 20, 1907	3.46	2.64	5.09	.74	11.93
Faith.....	Feb. 18, 1906	3.46	2.51	4.82	.69	11.48
Dora F.....	April 7, 1907	3.46	2.88	4.55	.69	11.58
Faith.....	Jan. 6, 1907	3.46	2.56	4.60	.74	11.36
Dora F.....	May 26, 1907	3.48	2.98	4.66	.74	11.86
Topsy.....	Nov. 11, 1906	3.49	3.22	4.91	.67	12.29
Faith.....	Nov. 25, 1906	3.50	2.83	4.61	.65	11.59
Faith.....	Nov. 11, 1906	3.50	2.73	4.85	.63	11.71
Fay.....	Feb. 5, 1905	3.50	2.58	4.82	.72	11.62
Rose H.....	Jan. 19, 1904	3.50	2.64	4.67	.65	11.46
Cotton.....	Jan. 12, 1904	3.51	2.74	4.91	.74	11.90
Doretta.....	May 5, 1907	3.51	2.80	5.00	.64	11.95
Cylene.....	Feb. 17, 1907	3.52	2.93	4.45	.76	11.66
Loula.....	Oct. 13, 1907	3.53	2.89	5.12	.69	12.23
Loula.....	Oct. 27, 1907	3.54	2.86	4.52	.67	11.59
Fay.....	Feb. 4, 1906	3.54	2.64	4.93	.71	11.22
Dora F.....	May 5, 1907	3.56	2.99	4.75	.73	12.03
Rose H.....	Feb. 16, 1904	3.57	2.75	5.14	.68	12.14
Doretta.....	Nov. 17, 1907	3.58	2.70	4.36	.70	11.34
Faith.....	Nov. 10, 1907	3.58	2.62	4.71	.73	11.64
Lola.....	Feb. 10, 1907	3.59	2.82	5.07	.67	12.15
Fay.....	Jan. 6, 1907	3.60	2.54	4.48	.75	11.37
Lola.....	Dec. 30, 1906	3.60	2.62	4.99	.71	11.92
Doretta.....	June 16, 1907	3.60	2.89	4.69	.68	11.86
Faith.....	March 10, 1907	3.61	2.73	4.77	.68	11.79
Fay.....	Dec. 16, 1906	3.62	2.86	4.68	.73	11.89
Fay.....	Jan. 7, 1906	3.63	3.33	4.59	.70	12.25
Doretta.....	April 22, 1907	3.64	2.74	4.95	.66	11.99
Doretta.....	May 19, 1907	3.65	2.83	4.74	.64	11.86
Lola.....	March 24, 1907	3.66	2.69	5.14	.70	12.19
Cylene.....	May 5, 1907	3.67	3.33	4.97	.73	12.70
Faith.....	April 21, 1907	3.68	2.80	4.80	.68	11.96
Dora F.....	June 9, 1907	3.69	3.59	4.27	.77	12.32
Topsy.....	Nov. 19, 1905	3.70	2.88	4.93	.71	12.22
Fay.....	Feb. 17, 1907	3.73	2.68	4.48	.71	11.60
Doretta.....	June 2, 1907	3.75	2.91	4.55	.66	11.87
(55)	Total.....	192.55	154.52	261.34	38.56	646.37
	Average.....	3.50	2.81	4.75	.70	11.76

COMPOSITION OF MILK AVERAGING 4 PER CENT FAT
 RANGE FROM 3.75 TO 4.25 PER CENT FAT

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Topsy	Dec. 17, 1905	3.76	2.75	5.07	0.69	12.27
Fay	May 19, 1907	3.78	2.65	4.57	.69	11.69
Fay	Jan. 12, 1904	3.79	2.99	4.36	.76	11.90
Faith	Nov. 17, 1907	3.80	2.68	4.52	.73	11.73
Faith	Oct. 20, 1907	3.81	2.68	4.64	.62	11.75
Topsy	May 5, 1907	3.82	3.18	5.05	.68	12.73
Faith	Oct. 13, 1907	3.83	2.69	4.55	.66	11.73
Faith	Jan. 21, 1906	3.83	2.43	4.68	.70	11.64
Pride	Nov. 3, 1907	3.84	3.24	4.75	.70	12.53
Trust	Feb. 16, 1904	3.85	2.77	4.74	.71	12.07
Faith	Dec. 16, 1906	3.85	2.75	4.40	.71	11.71
Cylene	June 16, 1907	3.86	3.28	4.34	.72	12.20
Sweet C	Nov. 11, 1906	3.86	3.62	5.10	.73	13.31
Topsy	Feb. 17, 1907	3.86	3.13	5.03	.71	12.73
Topsy	Jan. 6, 1907	3.87	3.12	5.05	.76	12.80
Topsy	April 21, 1907	3.88	3.36	4.95	.72	12.91
Faith	Nov. 3, 1907	3.91	2.67	4.35	.70	11.63
Loula	Nov. 17, 1907	3.92	2.79	4.91	.68	12.30
Sweet C	July 28, 1907	3.92	3.41	4.98	.66	12.97
Fay	March 10, 1907	3.94	2.66	4.66	.67	11.93
Cylene	June 2, 1907	3.94	3.57	4.37	.72	12.60
Topsy	Jan. 21, 1906	3.94	3.02	4.85	.74	12.55
Loula	Nov. 24, 1907	3.95	2.83	4.70	.72	12.20
Swiss	Jan. 19, 1904	3.95	3.00	4.94	.66	12.55
Topsy	June 2, 1907	3.96	3.66	4.70	.64	12.96
Fay	March 31, 1907	3.96	2.64	4.49	.65	11.74
Betty	Jan. 16, 1905	3.97	2.93	5.16	.71	12.77
Trusty Lee	Nov. 25, 1906	3.97	3.46	5.01	.67	13.11
Topsy	June 16, 1907	3.97	3.65	4.73	.66	13.01
Swiss	Sept. 22, 1907	3.98	3.23	4.68	.68	12.57
Swiss	Oct. 14, 1906	3.99	3.90	5.09	.78	13.76
Trusty Lee	Nov. 18, 1906	4.01	3.82	4.82	.67	13.32
Pride	Nov. 17, 1907	4.01	2.98	4.95	.70	12.64
Topsy	March 31, 1907	4.02	3.19	4.81	.66	12.68
Topsy	Feb. 18, 1906	4.03	3.05	5.11	.62	12.81
Sweet C	Jan. 21, 1906	4.07	3.10	5.14	.70	13.01
Fay	April 21, 1907	4.07	2.68	4.61	.69	12.05
Fay	June 2, 1907	4.07	2.88	4.75	.66	12.36
Star II	Dec. 19, 1904	4.08	2.98	5.19	.68	12.93
Tricksey	Oct. 21, 1906	4.09	3.25	5.02	.67	13.03
Pride	Nov. 14, 1904	4.10	2.89	5.06	.71	12.76
Thorney	Nov. 4, 1906	4.10	3.64	4.88	.76	13.38
Fay	May 5, 1907	4.12	2.51	4.85	.67	12.15
Pride	Nov. 24, 1907	4.12	2.87	5.19	.65	12.83
Sweet C	Dec. 17, 1905	4.14	3.05	5.32	.72	13.23
Betty 2	Feb. 20, 1905	4.14	2.75	5.35	.69	12.93
Sweet C	April 21, 1907	4.15	3.60	4.79	.70	13.24
Trusty Lee	Jan. 6, 1907	4.17	2.92	4.88	.72	12.69
Pearl	Nov. 14, 1906	4.20	3.05	5.13	.70	13.08
Daisy	Nov. 18, 1906	4.21	3.99	5.00	.70	13.90
Tricksey	Nov. 16, 1903	4.21	2.89	4.76	.71	12.57
L'Etoile	March 10, 1903	4.22	2.81	4.82	.71	12.56
Pride	April 2, 1907	4.22	3.19	4.86	.68	12.95
Alzanka	Nov. 16, 1903	4.23	3.06	4.64	.72	12.65

COMPOSITION OF MILK AVERAGING 4 PER CENT FAT
 RANGE FROM 3.75 TO 4.25 PER CENT FAT—*Continued*

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Trusty Lee.....	Dec. 16, 1906	4.25	2.89	4.80	.70	12.64
Sweet C.....	Dec. 23, 1906	4.25	3.35	5.13	.71	13.44
Pride.....	Nov. 18, 1906	4.25	3.60	4.90	.69	13.44
(57)	Total.....	228.09	175.73	276.18	39.62	719.62
	Average.....	4.00	3.08	4.85	.69	12.62

COMPOSITION OF MILK AVERAGING 4.5 PER CENT FAT
 RANGE FROM 4.25 TO 4.75 PER CENT FAT

		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Sweet C.....	April 7, 1907	4.26	3.50	5.04	0.70	13.50
Pride.....	Nov. 16, 1903	4.27	3.07	5.15	.74	13.23
Sweet C.....	Feb. 18, 1906	4.28	3.24	5.04	.75	13.31
Duchess.....	Dec. 2, 1906	4.28	2.98	4.97	.75	12.98
Pearl.....	Nov. 3, 1907	4.28	2.87	5.04	.69	12.88
Betty.....	Nov. 14, 1904	4.28	2.89	5.22	.72	13.11
Trusty Lee.....	Nov. 24, 1907	4.28	3.21	4.94	.74	13.17
Pearl.....	Oct. 27, 1907	4.29	2.92	4.76	.68	12.65
Polly.....	Oct. 20, 1907	4.29	3.22	5.01	.65	13.17
Pearl.....	Oct. 13, 1907	4.30	3.10	4.99	.70	13.09
Swiss.....	Oct. 21, 1906	4.31	3.53	5.37	.77	13.98
Sweet C.....	Nov. 19, 1905	4.31	3.24	4.98	.76	13.29
Pride.....	Nov. 10, 1907	4.31	3.07	4.77	.87	13.02
Pride.....	March 17, 1907	4.32	3.13	4.92	.69	13.06
Star II.....	Feb. 5, 1905	4.32	3.12	5.23	.71	13.38
Nora.....	Oct. 27, 1907	4.33	3.14	5.05	.77	13.29
Pearl.....	Oct. 20, 1907	4.33	2.91	4.94	.63	12.81
Pride.....	April 7, 1907	4.33	3.52	4.84	.69	13.38
Houston.....	Feb. 5, 1905	4.33	3.20	5.10	.77	13.40
Sweet C.....	May 19, 1907	4.34	3.32	4.99	.71	13.36
Trusty Lee.....	Nov. 17, 1907	4.34	3.64	5.19	.81	13.98
Sweet C.....	Feb. 3, 1907	4.35	3.82	4.95	.72	13.84
Prudie.....	Nov. 17, 1907	4.35	3.46	5.01	.79	13.61
White.....	Oct. 20, 1907	4.35	3.09	4.85	.70	12.99
Houston.....	Feb. 4, 1906	4.35	2.95	4.59	.71	12.60
Euroma IV.....	Jan. 12, 1904	4.35	3.18	5.04	.76	13.33
Trusty.....	Oct. 14, 1906	4.36	3.76	4.71	.73	13.56
Pearl.....	Nov. 17, 1907	4.36	2.80	5.04	.73	12.93
Pride.....	Dec. 23, 1906	4.36	2.92	5.09	.66	13.03
Tricksey.....	Oct. 7, 1906	4.37	3.43	4.83	.83	13.46
Tricksey.....	Oct. 28, 1906	4.37	3.31	4.77	.68	13.13
Houston.....	March 5, 1906	4.37	2.81	5.08	.68	12.94
Pride.....	Feb. 3, 1907	4.37	3.62	4.50	.67	13.16
Swiss.....	Oct. 6, 1907	4.38	3.63	4.75	.74	13.50
Houston.....	Dec. 19, 1904	4.38	3.16	5.12	.71	13.37
Alzanka.....	Feb. 9, 1904	4.39	3.10	5.03	.72	13.24
Sweet C.....	Jan. 13, 1907	4.39	3.26	5.08	.71	13.44
Sweet C.....	March 17, 1907	4.39	3.37	5.04	.74	13.54
Pride.....	Feb. 20, 1905	4.39	2.99	5.10	.68	13.16
Sweet C.....	Aug. 11, 1907	4.41	3.12	5.24	.67	13.44
Tricksey.....	Oct. 13, 1907	4.41	3.20	5.07	.66	13.34
Nora.....	Nov. 14, 1904	4.41	3.09	5.49	.70	13.69
Swiss.....	Dec. 1, 1903	4.42	3.26	5.25	.73	13.66
Sweet C.....	Dec. 2, 1906	4.42	3.25	5.11	.71	13.49
Swiss.....	Sept. 29, 1907	4.42	3.66	4.93	.82	13.83
Trusty.....	Sept. 22, 1907	4.43	3.60	4.91	.72	13.66

COMPOSITION OF MILK AVERAGING 4.5 PER CENT FAT
 RANGE FROM 4.25 TO 4.75 PER CENT FAT—*Continued*

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Pearl.....	Nov. 18, 1906	4.43	3.21	5.20	.70	13.54
White.....	Oct. 6, 1907	4.43	3.25	4.89	.92	13.49
White.....	Nov. 3, 1907	4.43	3.27	4.88	.71	13.29
Pride.....	Jan. 16, 1905	4.43	3.13	4.82	.73	13.11
Pearl.....	Oct. 6, 1907	4.44	3.18	4.61	.69	12.92
Pearl.....	Nov. 24, 1907	4.44	2.75	5.21	.65	13.05
Nora.....	Nov. 16, 1903	4.45	2.91	4.99	.70	13.05
Swiss.....	Nov. 11, 1906	4.45	3.50	5.08	.73	13.76
Star II.....	March 24, 1905	4.45	3.18	5.03	.78	13.44
Nora.....	Jan. 7, 1906	4.47	3.12	5.22	.72	13.53
Nora.....	Nov. 3, 1907	4.48	3.43	4.89	.87	13.67
Pride.....	Feb. 24, 1907	4.48	3.16	4.99	.69	13.32
Trust.....	Nov. 11, 1906	4.48	3.57	4.68	.71	13.44
Rose L.....	Jan. 19, 1904	4.49	3.39	4.80	.75	13.43
Nora.....	Oct. 20, 1907	4.49	3.24	5.22	.71	13.66
Pride.....	March 5, 1906	4.50	3.06	5.12	.75	13.43
Tricksey.....	Oct. 27, 1907	4.50	3.30	5.07	.70	13.57
Polly.....	Oct. 27, 1907	4.51	3.12	4.58	.97	13.18
Daisy.....	Dec. 9, 1906	4.51	4.03	5.18	.80	14.52
Swiss.....	Oct. 13, 1907	4.53	3.54	4.73	.72	13.52
Trusty Lee.....	Dec. 17, 1905	4.53	3.17	5.18	.73	13.61
Sweet C.....	Feb. 24, 1907	4.54	3.74	4.94	.74	13.96
Swiss.....	Nov. 25, 1906	4.54	3.57	4.96	.68	13.75
Trust.....	Oct. 28, 1906	4.55	3.48	4.58	.74	13.35
Swiss.....	Oct. 28, 1906	4.55	3.62	5.03	.70	13.90
Hylene.....	Oct. 14, 1906	4.56	3.39	4.97	.74	13.66
White.....	Nov. 24, 1907	4.56	3.21	4.62	.76	13.15
White.....	Oct. 28, 1906	4.58	3.06	5.25	.72	13.61
Nora.....	March 3, 1903	4.59	3.50	5.06	.71	13.86
Nora.....	March 5, 1906	4.67	3.15	5.35	.68	13.85
Pride.....	Feb. 4, 1906	4.67	3.14	4.85	.73	13.39
Tricksey.....	Nov. 11, 1906	4.68	3.40	4.93	.70	13.71
Trusty.....	Oct. 13, 1907	4.68	3.39	4.73	.75	13.55
Trusty.....	Oct. 20, 1907	4.68	3.47	4.84	.72	13.71
Trusty Lee.....	Feb. 17, 1907	4.68	3.35	4.77	.74	13.54
Tessa.....	Nov. 3, 1907	4.69	3.17	5.16	.70	13.72
White.....	Nov. 25, 1906	4.69	3.40	5.20	.61	13.90
Prudie.....	Nov. 4, 1906	4.70	3.13	5.03	.74	13.60
Swiss.....	Oct. 27, 1907	4.70	3.54	4.52	.88	13.64
Nora.....	Feb. 16, 1904	4.72	3.18	5.36	.69	13.95
White.....	Nov. 10, 1907	4.73	3.30	4.73	.74	13.50
Rose L.....	Dec. 1, 1903	4.73	3.58	5.07	.74	14.12
Swiss.....	Jan. 27, 1907	4.73	3.61	4.86	.77	13.97
Tessa.....	Oct. 27, 1907	4.73	3.56	4.71	.93	13.93
Duchess.....	Nov. 24, 1907	4.74	3.20	4.81	.72	13.47
Polly.....	Nov. 3, 1907	4.74	3.19	4.90	.71	13.54
White.....	Nov. 17, 1907	4.74	3.33	4.59	.78	13.44
Trusty Lee.....	Jan. 21, 1906	4.75	3.21	5.05	.71	13.72
Swiss.....	Dec. 16, 1906	4.59	3.41	5.20	.73	13.93
Tricksey.....	Oct. 20, 1907	4.59	3.14	5.08	.68	13.49
Trusty Lee.....	Feb. 20, 1905	4.59	2.98	5.30	.72	13.59
Pearl.....	Nov. 10, 1907	4.60	2.87	4.47	.91	12.85
Swiss.....	Nov. 24, 1907	4.60	3.61	4.73	.75	13.69
Pride.....	March 3, 1903	4.61	3.10	4.99	.70	13.40
Hylene.....	Nov. 17, 1907	4.61	3.31	5.25	.72	13.89
Trusty Lee.....	Jan. 27, 1907	4.62	3.25	4.74	.69	13.30
Pride.....	Jan. 7, 1906	4.62	3.28	4.25	.62	12.77
Swiss.....	Nov. 17, 1907	4.63	3.70	4.87	.78	13.98
Swiss.....	Jan. 21, 1906	4.65	3.16	5.01	.76	13.58

COMPOSITION OF MILK AVERAGING 4.5 PER CENT FAT
RANGE FROM 4.25 TO 4.75 PER CENT FAT

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Pride.....	Dec. 2, 1906	4.65	3.06	5.06	.69	13.46
Swiss.....	Nov. 10, 1907	4.65	3.64	4.72	.75	13.76
Nora.....	Jan. 19, 1904	4.66	2.94	5.16	.71	13.47
Pride.....	Feb. 16, 1904	4.66	3.17	5.27	.69	13.79
Swiss.....	Feb. 5, 1905	4.66	3.34	5.14	.76	13.90
Houston.....	Jan. 12, 1904	4.67	2.90	4.77	.73	13.07
Tricksey.....	Nov. 24, 1907	4.67	3.20	5.12	.67	13.66
Trust.....	Oct. 21, 1906	4.67	3.35	4.88	.73	13.63
Swiss.....	Jan. 6, 1907	4.75	3.35	5.13	.77	14.00
Sweet C.....	Feb. 16, 1904	4.75	2.96	5.27	.69	13.67
White.....	Jan. 6, 1907	4.75	3.10	5.27	.75	13.87
(116)	Total.....	522.02	378.86	577.04	84.83	1,562.75
	Average.....	4.50	3.27	4.97	.73	13.47

COMPOSITION OF MILK AVERAGING 5 PER CENT FAT
RANGE FROM 4.75 TO 5.25 PER CENT FAT

		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Pride.....	Dec. 3, 1905	4.76	3.43	4.62	0.76	13.57
Nora.....	Dec. 3, 1905	4.77	3.03	5.23	.72	13.75
Pearl.....	Jan. 6, 1907	4.77	3.21	5.22	.75	13.95
Euroma IV.....	Feb. 9, 1904	4.79	3.05	5.19	.72	13.75
Pearl.....	Jan. 27, 1907	4.79	3.69	5.03	.70	14.21
Swiss.....	Nov. 3, 1907	4.79	3.61	4.81	.76	13.97
Trusty Lee.....	Nov. 19, 1905	4.80	3.10	4.99	.72	13.61
Euroma.....	Dec. 23, 1906	4.80	3.48	5.26	.73	14.27
Pearl.....	Feb. 17, 1907	4.80	3.79	4.69	.75	14.03
Nora.....	Feb. 20, 1905	4.81	3.41	5.36	.72	14.30
Trusty Lee.....	March 10, 1907	4.81	3.46	5.25	.74	14.26
White.....	Dec. 16, 1906	4.81	3.25	4.97	.70	13.73
Betty.....	Feb. 9, 1904	4.82	3.27	5.15	.70	13.94
Nora.....	Nov. 10, 1907	4.82	3.41	4.95	.73	13.91
Prudie.....	Nov. 18, 1906	4.82	3.55	5.23	.72	14.32
Prudie.....	Oct. 14, 1906	4.83	3.32	4.75	.69	13.59
Swiss.....	Oct. 20, 1907	4.83	3.70	4.61	.77	13.91
Trust.....	Feb. 24, 1907	4.83	3.56	4.64	.75	13.78
Pearl.....	March 10, 1907	4.84	3.49	5.07	.68	14.08
Houston.....	Jan. 7, 1906	4.85	2.91	4.84	.67	13.27
Nora.....	Feb. 4, 1906	4.85	3.20	4.81	.71	13.57
Trusty.....	Oct. 6, 1907	4.85	3.50	5.11	.73	14.19
Trusty Lee.....	May 19, 1907	4.85	3.23	4.91	.73	13.72
Star II.....	Jan. 19, 1904	4.86	3.32	5.02	.70	13.90
Trusty.....	Nov. 18, 1906	4.86	3.36	5.37	.62	14.21
Nora.....	Nov. 17, 1907	4.88	3.31	4.99	.70	13.88
Duchess.....	Dec. 23, 1906	4.89	3.08	4.74	.74	13.45
Tricksey.....	Nov. 17, 1907	4.89	3.37	5.15	.69	14.10
Nora.....	Oct. 7, 1906	4.90	3.85	4.68	.73	14.16
Nora.....	Oct. 21, 1906	4.90	3.88	5.03	.75	14.56
Tessa.....	Nov. 10, 1907	4.91	3.05	5.30	.71	13.97
Tricksey.....	Dec. 2, 1906	4.91	3.70	4.95	.74	14.30
Trust.....	Dec. 23, 1906	4.91	3.66	4.65	.73	13.95
Nora.....	Nov. 11, 1906	4.92	3.40	5.28	.66	14.26
Nora.....	Dec. 23, 1906	4.92	3.80	4.92	.76	14.40
Tricksey.....	Nov. 3, 1907	4.93	3.32	5.07	.72	14.04
White.....	Jan. 27, 1907	4.92	3.37	5.14	.69	14.13
Duchess.....	Nov. 17, 1907	4.94	3.11	5.05	.73	13.83

COMPOSITION OF MILK AVERAGING 5 PER CENT FAT
 RANGE FROM 4.75 TO 5.25 PER CENT FAT—Continued

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Star II	March 5, 1906	4.95	3.41	4.97	.78	14.11
Swiss	March 31, 1907	4.95	3.30	5.16	.72	14.13
Swiss	April 21, 1907	4.95	3.34	5.03	.75	14.07
Swiss	March 10, 1907	4.96	3.50	5.02	.76	14.24
Tricksey	Dec. 23, 1906	4.96	3.39	5.30	.76	14.41
Trusty Lee	March 31, 1907	4.97	3.56	5.24	.73	14.50
Daisy	Dec. 30, 1906	4.98	4.14	5.14	.78	15.04
Pearl	Jan. 7, 1906	4.99	3.96	4.87	.73	14.55
Trust	March 17, 1907	4.99	3.59	4.50	.76	13.84
Trusty	Nov. 10, 1907	4.99	3.44	4.97	.76	14.16
Swiss	May 5, 1907	5.00	3.52	5.22	.70	14.44
Trusty	Nov. 4, 1906	5.00	3.18	5.11	.71	14.00
Betty II	Jan. 12, 1904	5.02	3.09	5.12	.73	13.96
Euroma	Feb. 19, 1904	5.02	3.05	5.12	.70	13.89
White	Jan. 21, 1906	5.03	3.34	4.95	.73	14.05
Pride	Jan. 19, 1904	5.03	3.16	5.12	.68	13.99
Duchess	Jan. 13, 1907	5.03	3.08	4.96	.75	13.82
Swiss	Feb. 17, 1907	5.03	3.57	4.80	.78	14.18
Tricksey	Nov. 10, 1907	5.03	3.38	4.89	.72	14.02
Nora	Jan. 16, 1905	5.05	3.42	5.31	.76	14.54
Swiss	May 19, 1907	5.05	3.39	5.00	.73	14.17
Trusty	Nov. 3, 1907	5.05	3.44	4.75	.76	14.00
Duchess	May 26, 1907	5.06	3.14	5.18	.67	14.05
Tricksey	June 9, 1907	5.06	4.53	4.65	.78	15.02
Trusty	Nov. 17, 1907	5.07	3.46	5.11	.79	14.43
Star	Dec. 1, 1903	5.08	3.49	5.24	.76	14.57
Euroma	Jan. 12, 1904	5.08	3.12	5.20	.71	14.11
Star II	Dec. 3, 1905	5.08	4.02	5.97	.76	14.83
Swiss	Feb. 18, 1906	5.08	3.25	5.10	.75	14.18
Pearl	March 31, 1907	5.08	3.48	4.90	.67	14.13
Houston	Dec. 3, 1904	5.09	3.68	4.99	.78	14.54
White	Dec. 17, 1905	5.09	3.11	4.92	.72	13.83
Nora	Feb. 24, 1907	5.09	3.74	5.08	.72	14.63
Nora	Oct. 28, 1906	5.10	3.89	4.71	.73	14.43
Trusty	Dec. 9, 1906	5.10	3.43	5.27	.70	14.50
Trusty Lee	May 5, 1907	5.10	3.35	4.91	.73	14.09
Trusty Lee	Jan. 19, 1904	5.12	3.87	4.85	.71	14.55
Houston	Feb. 23, 1907	5.12	3.60	5.04	.74	14.50
Trust	April 7, 1907	5.13	3.71	4.58	.73	14.15
White	May 5, 1907	5.13	3.24	4.98	.67	14.02
Star	Jan. 7, 1907	5.14	3.68	5.04	.70	14.56
Polly	Nov. 24, 1907	5.14	3.48	4.92	.68	14.22
Duchess	Nov. 14, 1904	5.15	3.45	4.84	.78	14.22
Nora	Dec. 2, 1906	5.15	3.80	4.91	.73	14.59
White	March 10, 1907	5.15	3.30	5.26	.71	14.42
Duchess	Feb. 24, 1907	5.17	3.68	4.44	.81	14.10
Nora	Jan. 13, 1907	5.17	3.90	4.93	.73	14.73
Tricksey	Dec. 17, 1905	5.18	3.21	5.39	.69	14.47
Euroma	June 23, 1907	5.18	3.27	5.08	.63	14.16
Helen	Nov. 17, 1907	5.18	3.08	5.14	.69	14.09
Hylene	Nov. 11, 1907	5.18	3.76	4.70	.80	14.44
Star II	Feb. 4, 1906	5.19	3.65	4.69	.76	14.29
Swiss	Nov. 19, 1905	5.20	3.38	4.72	.77	14.07
Trusty	Dec. 30, 1906	5.20	3.37	5.24	.72	14.53
Hazel	Sept. 22, 1907	5.21	3.43	4.98	.70	14.32
Swiss	June 2, 1907	5.21	3.50	5.35	.75	14.81
Duchess	March 17, 1907	5.22	3.45	4.63	.80	14.10
Tricksey	Jan. 13, 1907	5.22	3.41	4.81	.72	14.16
Duchess	March 17, 1907	5.22	3.45	4.63	.80	14.10

COMPOSITION OF MILK AVERAGING 5 PER CENT FAT
RANGE FROM 4.75 TO 5.25 PER CENT FAT—Continued

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Tricksey.....	Nov. 19, 1905	5.23	3.34	4.97	.72	14.26
Hylene.....	Nov. 18, 1906	5.23	3.37	5.19	.61	14.40
Tricksey.....	Feb. 3, 1907	5.23	3.94	4.62	.68	14.47
Euroma.....	May 26, 1907	5.24	3.31	4.70	.67	13.92
Duchess.....	Feb. 20, 1905	5.25	3.44	5.15	.79	14.63
Hylene.....	Nov. 4, 1906	5.25	3.17	4.83	.71	13.96
(103)	Total.....	515.82	355.41	514.42	74.87	1,459.51
	Average.....	5.00	3.45	4.99	.73	14.17

COMPOSITION OF MILK AVERAGING 5.5 PER CENT FAT
RANGE FROM 5.25 TO 5.75 PER CENT FAT

		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Trusty.....	Jan. 20, 1907	5.26	3.46	5.23	0.69	14.64
White.....	March 31, 1907	5.26	3.26	4.90	.68	14.10
White.....	April 21, 1907	5.26	3.43	4.86	.70	14.25
Daisy.....	Jan. 20, 1907	5.27	4.23	5.11	.75	15.36
Daisy.....	March 24, 1907	5.27	3.60	4.91	.73	14.51
Duchess.....	Feb. 3, 1907	5.27	3.67	4.43	.73	14.10
White.....	May 19, 1907	5.27	3.25	4.85	.69	14.06
Betty II.....	March 3, 1903	5.28	3.88	5.14	.82	15.12
Puss.....	Jan. 19, 1904	5.28	3.35	4.59	.77	13.99
Trusty Lee.....	Feb. 18, 1906	5.28	3.19	4.72	.77	13.96
Nora.....	March 17, 1907	5.28	3.93	4.85	.73	14.79
Houston.....	Oct. 28, 1906	5.29	3.99	5.05	.78	15.11
Polly.....	Nov. 10, 1907	5.29	3.03	5.18	.73	14.23
Duchess.....	Dec. 3, 1905	5.30	3.69	4.86	.68	14.53
White.....	June 2, 1907	5.30	3.63	4.74	.75	14.42
Houston.....	March 17, 1907	5.31	3.79	4.96	.76	14.82
Duchess.....	March 3, 1903	5.33	3.42	4.58	.76	14.09
Tricksey.....	May 12, 1907	5.33	4.02	5.19	.79	15.33
Tricksey.....	March 17, 1907	5.34	3.60	4.74	.76	14.44
Letta.....	Feb. 9, 1904	5.36	3.24	5.03	.74	14.37
Houston.....	May 27, 1907	5.36	3.48	4.99	.71	14.54
Trusty Lee.....	June 2, 1907	5.36	3.62	4.92	.71	14.61
Duchess.....	June 9, 1907	5.37	3.49	4.65	.71	14.22
Betty II.....	Nov. 19, 1905	5.38	3.86	4.83	.77	14.84
White.....	Feb. 18, 1906	5.38	3.42	4.67	.75	14.22
Houston.....	May 12, 1907	5.39	3.54	5.11	.71	14.75
Tricksey.....	April 8, 1907	5.41	3.64	5.05	.77	14.87
Duchess.....	Jan. 16, 1905	5.42	3.65	4.66	.70	14.43
Euroma.....	Nov. 19, 1905	5.42	3.31	5.31	.72	14.76
Swiss.....	June 30, 1907	5.42	3.33	5.16	.66	14.57
Hazel.....	Sept. 29, 1907	5.43	3.31	5.11	.79	14.64
Tulip.....	Feb. 24, 1907	5.43	3.98	5.21	.81	15.43
Duchess.....	April 7, 1907	5.44	3.76	4.36	.73	14.29
Tricksey.....	Jan. 21, 1906	5.47	3.27	5.17	.64	14.55
Houston.....	Oct. 7, 1906	5.47	4.04	4.26	.79	14.56
Klondike.....	Feb. 9, 1904	5.48	3.85	5.14	.72	15.19
Duchess.....	April 28, 1907	5.49	3.63	4.62	.66	14.40
Letta.....	Jan. 7, 1906	5.50	3.43	4.77	.65	14.33
Houston.....	Oct. 21, 1906	5.51	4.10	4.77	.77	15.15
Duchess.....	Nov. 16, 1903	5.52	3.54	4.98	.79	14.83
Duchess.....	Feb. 4, 1906	5.52	3.64	4.65	.77	14.58
Pearl.....	Feb. 4, 1906	5.52	3.90	4.96	.74	15.12
Daisy.....	May 26, 1907	5.52	3.48	4.98	.69	14.67
Letta.....	Jan. 12, 1904	5.53	3.34	4.74	.74	14.35
Daisy.....	Aug. 18, 1907	5.53	3.68	4.54	.70	14.45
Trusty.....	April 14, 1907	5.53	3.96	5.06	.68	15.23

COMPOSITION OF MILK AVERAGING 5.5 PER CENT FAT
RANGE FROM 5.25 TO 5.75 PER CENT FAT—Continued

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Houston.....	April 7, 1907	5.54	4.05	4.52	.73	14.84
Prudie.....	Aug. 4, 1907	5.54	3.51	5.25	.67	14.97
Duchess.....	March 5, 1906	5.55	3.42	4.92	.69	14.58
Houston.....	Jan. 13, 1907	5.55	3.60	5.07	.75	14.97
Hylene.....	Dec. 9, 1906	5.55	3.86	4.88	.76	15.05
Lilly.....	Dec. 1, 1904	5.56	3.90	4.58	.79	14.83
Daisy.....	Aug. 4, 1907	5.56	3.34	4.76	.72	14.38
Euroma.....	April 28, 1907	5.56	3.60	5.19	.62	14.97
Euroma.....	March 17, 1907	5.57	3.40	4.96	.74	14.67
Houston.....	Dec. 23, 1906	5.58	3.67	4.90	.75	14.90
Trusty.....	March 3, 1907	5.58	3.59	5.04	.75	14.96
Trusty Lee.....	Dec. 1, 1903	5.59	3.89	4.83	.78	15.09
Euroma.....	Dec. 17, 1905	5.59	3.31	5.02	.71	14.63
Thorney.....	Dec. 30, 1906	5.60	3.71	4.55	.76	14.62
Prudie.....	April 14, 1907	5.61	4.03	4.95	.66	15.25
Tulip.....	April 14, 1907	5.61	4.06	4.86	.70	15.23
Euroma.....	Jan. 21, 1906	5.62	3.60	5.22	.74	15.18
Duchess.....	May 12, 1907	5.62	3.13	5.00	.72	14.47
Euroma.....	June 9, 1907	5.62	3.54	4.91	.69	14.76
Letta.....	Feb. 4, 1906	5.63	3.16	5.25	.75	14.79
Hazel.....	Oct. 6, 1907	5.63	3.53	5.07	.68	14.91
Helen.....	Nov. 10, 1907	5.63	3.22	4.87	.72	14.44
Houston.....	Feb. 3, 1907	5.63	4.07	4.80	.74	15.24
Prudie.....	May 26, 1907	5.63	3.61	5.19	.61	15.04
Tricksey.....	May 26, 1907	5.63	4.58	4.66	.79	15.66
Daisy.....	March 3, 1907	5.64	4.14	5.01	.76	15.55
Houston.....	Nov. 11, 1906	5.64	4.08	4.96	.72	15.40
Daisy.....	June 9, 1907	5.65	3.76	5.10	.76	15.27
Houston.....	April 28, 1907	5.65	3.83	5.13	.66	15.27
Daisy.....	May 12, 1907	5.66	3.65	5.14	.72	15.17
Euroma.....	Jan. 13, 1907	5.67	3.22	5.27	.76	14.92
Prudey.....	Dec. 9, 1906	5.67	3.82	5.28	.75	15.52
Trusty.....	Feb. 10, 1907	5.67	3.58	4.92	.67	14.84
Klondike.....	Jan. 12, 1904	5.68	3.91	4.47	.78	14.84
Tricksey.....	Feb. 18, 1906	5.68	3.32	4.55	.73	14.28
Leeoma.....	Jan. 12, 1904	5.68	3.38	4.93	.73	14.72
Klondike.....	Feb. 5, 1905	5.70	4.12	4.52	.74	15.08
Daisy.....	Feb. 10, 1907	5.70	3.88	4.95	.74	15.27
Lassie.....	Sept. 22, 1907	5.70	3.71	5.20	.62	15.23
Prudie.....	March 24, 1907	5.70	3.65	5.32	.67	15.34
Tulip.....	Oct. 14, 1906	5.73	4.39	4.79	.71	15.62
Hazel.....	Nov. 24, 1907	5.74	3.39	4.97	.70	14.80
Prudie.....	Dec. 30, 1906	5.74	3.81	5.25	.74	15.54
(89)	Total.....	489.71	324.93	437.60	64.67	1,316.53
	Average.....	5.50	3.65	4.92	.73	14.80

COMPOSITION OF MILK AVERAGING 6 PER CENT FAT
RANGE FROM 5.75 TO 6.25 PER CENT FAT

		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Tessa.....	Nov. 4, 1906	5.77	3.75	4.84	0.73	15.09
Prudie.....	Aug. 18, 1907	5.78	3.83	4.59	.69	14.89
Hazel.....	Nov. 3, 1907	5.79	3.51	4.43	.73	14.46
Daisy.....	April 28, 1907	5.82	3.77	5.20	.68	15.47
Hazel.....	Oct. 13, 1907	5.83	3.59	4.66	.75	14.83
Hazel.....	Oct. 27, 1907	5.84	3.57	4.93	.77	15.11
Duchess.....	Jan. 12, 1904	5.88	3.68	5.03	.78	15.37
Tulip.....	Nov. 18, 1906	5.88	4.32	5.25	.64	16.09

COMPOSITION OF MILK AVERAGING 6 PER CENT FAT
RANGE FROM 5.75 TO 6.25 PER CENT FAT—Continued

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P.ct.	P. ct.
Duchess	Jan. 7, 1906	5.89	3.36	5.37	.82	15.44
Euroma	Feb. 18, 1906	5.89	3.75	5.18	.74	15.56
Lassie	Oct. 14, 1906	5.91	3.98	4.92	.75	15.56
Letta	March 5, 1906	5.92	3.40	5.12	.71	15.15
Hylene	March 24, 1907	5.92	3.27	4.85	.71	14.75
Lassie	Sept. 29, 1907	5.92	3.68	4.99	.85	15.44
Lassie	Oct. 6, 1907	5.92	3.87	4.98	.68	15.45
Prudie	Jan. 20, 1907	5.93	3.98	5.18	.72	15.81
Klondike	Dec. 19, 1904	5.94	4.17	4.82	.78	15.71
Prudie	March 3, 1907	5.95	3.54	5.24	.67	15.40
Thornie	May 26, 1907	5.96	3.48	5.19	.66	15.29
Hylene	Feb. 10, 1907	5.97	3.31	4.97	.72	14.97
Hylene	March 14, 1907	5.99	3.80	4.43	.69	14.91
Trusty	May 12, 1907	6.00	3.74	5.13	.68	15.55
Myrtle	Feb. 18, 1906	6.01	3.82	4.74	.82	15.39
Hylene	March 3, 1907	6.04	3.27	4.67	.72	14.70
Myrtle	Feb. 4, 1906	6.05	3.88	5.12	.84	15.89
Tessa	Nov. 18, 1906	6.06	4.13	4.94	.76	15.89
Myrtle	March 5, 1906	6.08	3.82	4.89	.76	15.55
Thorney	Jan. 20, 1907	6.08	3.80	4.78	.74	15.40
Tulip	Nov. 4, 1906	6.12	3.93	4.97	.74	15.76
Prudie	Feb. 10, 1907	6.13	3.87	4.96	.68	15.64
Prudie	May 12, 1907	6.13	3.82	5.21	.65	15.81
Lassie	Nov. 18, 1906	6.14	4.01	5.17	.68	16.00
Klondike	Nov. 14, 1904	6.19	4.39	4.52	.81	15.91
Lassie	Oct. 20, 1907	6.19	3.92	4.87	.71	15.69
Duchess	Feb. 9, 1904	6.21	3.63	4.54	.74	15.12
Leoma	Feb. 18, 1906	6.21	4.03	4.87	.82	15.93
Leoma	March 10, 1907	6.21	4.65	4.79	.84	16.49
Thorney	June 9, 1907	6.22	3.71	4.52	.70	15.15
Leoma	Feb. 17, 1907	6.24	4.85	4.72	.78	16.59
(39)	Total	234.01	148.88	191.58	28.74	603.21
	Average	6.00	3.82	4.91	.74	15.47

COMPOSITION OF MILK AVERAGING 6.5 PER CENT FAT
RANGE FROM 6.25 TO 6.75 PER CENT FAT

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Tessa	Oct. 14, 1906	6.29	3.70	4.63	0.74	15.36
Lassie	Nov. 4, 1906	6.30	3.86	4.89	.73	15.78
Leoma	Oct. 28, 1906	6.30	4.45	5.15	.67	16.57
Leoma	April 21, 1907	6.35	4.28	4.74	.78	16.15
Puss	Feb. 16, 1904	6.36	3.53	4.40	.73	15.02
Leoma	Nov. 11, 1906	6.36	4.60	4.99	.75	16.70
Leoma	Jan. 21, 1906	6.40	4.28	4.71	.83	16.22
Thorney	March 3, 1907	6.41	3.90	4.82	.74	15.87
Thorney	May 12, 1907	6.41	3.70	5.12	.64	15.87
Tessa	Dec. 30, 1906	6.42	4.13	5.12	.80	16.47
Leoma	Nov. 25, 1906	6.49	4.51	5.12	.74	16.86
Tulip	Jan. 20, 1907	6.49	4.15	5.12	.68	16.44
Lassie	Oct. 27, 1907	6.50	3.97	5.08	.74	16.29
Tessa	Dec. 9, 1906	6.53	4.07	5.11	.71	16.42
Thorney	March 24, 1907	6.55	3.82	4.67	.74	15.78
Leoma	Dec. 16, 1906	6.57	4.48	4.99	.82	16.86
Euroma III	Jan. 12, 1904	6.59	4.02	4.64	.70	15.95
Lassie	Nov. 10, 1907	6.61	4.10	4.64	.87	16.22
Thorney	April 28, 1907	6.62	3.83	4.98	.67	16.10

COMPOSITION OF MILK AVERAGING 6.5 PER CENT FAT
 RANGE FROM 6.25 TO 6.75 PER CENT FAT—Continued

Cow	Week Ended	Fat	Protein	Carbo- hydrates	Ash	Total Solids
		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Lassie	Nov. 3, 1907	6.66	3.94	5.13	.76	16.49
Leeoma	Jan. 6, 1907	6.66	4.51	4.83	.90	16.90
Tessa	April 14, 1907	6.67	4.32	4.48	.73	16.20
Lassie	May 26, 1907	6.73	4.00	5.21	.70	16.64
Tulip	Dec. 9, 1906	6.73	4.65	5.15	.76	17.29
(24)	Total	156.00	98.80	117.72	17.93	390.45
	Average	6.50	4.12	4.90	.75	16.27

COMPOSITION OF MILK AVERAGING 7 PER CENT FAT
 RANGE FROM 6.75 TO 7.25 PER CENT FAT

		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Lassie	Dec. 9, 1906	6.82	4.19	5.18	0.79	16.98
Euroma III	Dec. 1, 1903	6.85	4.15	4.69	.73	16.42
Thorney	Feb. 10, 1907	6.86	3.88	4.92	.73	16.39
Lassie	Nov. 24, 1907	6.91	4.12	4.92	.76	16.71
Lassie	Jan. 20, 1907	6.95	4.19	4.78	.76	16.68
Lassie	Nov. 17, 1907	6.99	4.20	4.66	.76	16.61
Tessa	Feb. 10, 1907	6.99	4.02	4.70	.74	16.45
Lassie	April 14, 1907	7.01	4.51	4.99	.73	17.24
Leeoma	Jan. 27, 1907	7.04	5.40	4.69	.77	17.90
Lassie	March 24, 1907	7.10	4.13	5.17	.76	17.16
Tessa	Jan. 27, 1907	7.15	4.10	5.10	.77	17.12
Puss	Dec. 1, 1903	7.17	3.91	4.21	.81	16.10
Euroma III	Feb. 9, 1904	7.17	4.08	4.86	.73	16.84
(13)	Total	91.01	54.88	62.87	9.84	218.60
	Average	7.00	4.22	4.84	.76	16.82

