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BULLETIN No. 80—NEW SERIES.

NOVEMBER, 1894.

ALFALFA FORAGE FOR MILCH COWS.

THE RESULTS FROM RATIONS CONTAINING ALFALFA AND THOSE OBTAINED FROM SOME OTHER SUMMER RATIONS.

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BULLETIN NO. 80—NEW SERIES.

ALFALFA FORAGE FOR MILCH COWS.

The importance of feeding leguminous crops has led to many inquiries concerning the value of alfalfa as forage for milch cows, for the alfalfa is much liked by cattle and other animals and contains an unusually large proportion of nitrogenous constituents. The rapid growth of the plant, which can be cut three times during the season, and often four times, makes it especially worthy of consideration where soiling methods are practiced.

A few of our farmers have grown good crops of alfalfa successfully for several years, but it does not seem suited to some sections of the state. Alfalfa has grown well on the station farm although the soil is a rather heavy clay. A field of alfalfa of 2 28 acres sown in 1890 yielded this season (1894) for the first two cuttings—the first during June and the second about August 1st—at the rate of 24500 pounds of green forage per acre. On account of very severe drought the third cutting was very light and only part of the field was cut for the fourth time. Another field of alfalfa of 1.3 acres sown in 1893 yielded at the rate of 33800 pounds of green forage per acre, as the total for four cuttings. The last two cuttings were very light on account of severe drought. The first two cuttings from May 11th to 31st and from July 9th to 28th, yielded at the rate of a little over 12 tons of green forage per acre. These fields had been steadily cropped and not well manured for some years before sowing to alfalfa and were not in condition to produce heavy crops.

As testimony in regard to the feeding value of alfalfa forage it is thought desirable to give the results of some feeding trials made during the past few years at this station in which alfalfa forage, oat-and-pea forage and some other foods have been fed. The results which are reported in this bulletin were obtained from animals in the stage of lactation where a fair flow of milk of normal composition would be expected, and any general change in the quantity or quality of the product, besides the gradual change as the period of lactation advanced, might be reasonably attri-

buted to the influence of the different foods. Individual records for each cow were kept, separate analyses of the milk having been made. Only the average results are here given. As varying amounts of milk of differing quality were given by different animals the actual weights of the different constituents yielded by each cow were considered in determining the average composition of all the milk.

A sufficient supply of one kind of forage was not always obtainable for periods longer than fifteen days—as a number of other animals besides those from which the results are here reported were always fed at the same time ;—but whenever a good succession was available one kind of forage was fed for a month. The periods of feeding are therefore often not so long as would be desired. For the purpose of securing data, other than that here reported, relative to the production of individual animals, it was necessary to feed a fairly constant proportion of grain at certain months of lactation. On this account no results are here reported that have been obtained when the forage was fed without grain. The grain was fed in moderate quantities, but always separately from the coarse fodder, so that if any should be left at any time it could be weighed. The grain was fed twice daily, at five o'clock A. M. and at five o'clock P. M. in generally equal quantities—when there was any difference the evening feed was one-half pound the greater. Forage or hay was fed at 5 o'clock A. M., at 11:30 A. M. and at 5 o'clock P. M. The forage and hay were generally fed in quantities likely to be entirely eaten but account was kept of any food left to the amount of one ounce. Only the weight of food actually consumed is given in the tables. The cows were milked at 5 o'clock A. M. and at 5 o'clock P. M. Analyses were made at frequent intervals of milk from each cow, and all the foods were analyzed.

In estimating the amounts of digestible constituents in the different foods the average co-efficients of digestibility obtained in digestion experiments made in this country and Germany were used. Whenever enough data were available the American co-efficients were used.

In calculating the cost of the rations, wheat bran was rated at $18 per ton, corn meal at $20, ground oats at $25, linseed meal, O. P., at $27, linseed meal, N. P., at $25, gluten meal at $25,

wheat middlings at $20, cotton-seed meal at $30, gluten feed at $18, and ground flaxseed at $60 per ton. All hay was rated at $10 per ton, corn silage at $3, roots at $3, and all green forage at $2 per ton. It is thought better to assume the one valuation for any food throughout all the trials, which extended over portions of four seasons, than to attempt to follow fluctuations of market price. Enough data are given to allow of recalculation, by any who desire, of the cost of rations at other prices for foods than those just stated. All forage has been placed at the same valuation per ton. The cost of production per ton of corn forage will hardly be the same as for oat-and-pea forage, etc. There is more labor necessary to establish a good stand of alfalfa than for the sowing of the oats and peas or similar crops, but after alfalfa is once established it will furnish three or more cuttings each season with little more labor expense than that of harvesting the crop. Not enough data are available, at present, however, to warrant us in fixing certain different cost valuations per ton.

Table I gives the results obtained in feeding fourteen cows from May 15th to July 15th, 1891. The average age of these cows was on June 1st, 3 years, and they had been in milk on the average 6.8 months at the beginning of this feeding trial.

From May 16th to May 31st inclusive corn silage was fed in the morning and at noon, mixed hay, clover and timothy, at night and a mixed grain (No. 16) consisting of six parts wheat bran, three parts corn meal, and two parts linseed meal O. P. The grain represented 48.6 per cent. of the cost of the ration and supplied 39.7 per cent. of the total digestible nutrients. The silage represented 30 0 per cent. of the cost of the ration and supplied 35.8 per cent. of the digestible nutrients.

From June 1st to June 15th, inclusive, corn silage was fed in the morning, alfalfa forage at noon and mixed hay at night. The grain fed (No. 17) consisted of four parts wheat bran, four parts ground oats, five parts corn meal, and two parts gluten meal. The grain represented 52.4 per cent. of the cost of the ration and supplied 38.3 per cent. of the digestible nutrients. The silage and forage represented 24.6 per cent. of the cost of the ration and supplied 37.7 per cent. of the digestible nutrients.

From June 16th to June 30th, inclusive, alfalfa forage was fed morning and noon, and hay at night. The same grain was fed as

TABLE I—A.

Period.	Average live weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Mixed hay. Lbs.	Grain No. 16. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
May 16 to 31..	823.6	52.43	26.75	——	6.20	6.66 No. 17.	39.61	16.99
May 1 to June 15.....	833.2	60.92	12.63	14.91	6.32	6 72	40.58	18.65
June 16 to 30..	843.7	61.63	—— Oat-and-pea forage.	28.86	6.33	6.75	41.94	19.77
July 1 to 15...	846.5	53.22	30.84	——	6.35	6.75	43.94	18.45

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-Free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food. (Fats x2¼.)
May 16 to 31..	22.62	.91	2.59	1.00	3.81	8.69	16.08	10.35	1:5.7
June 1 to 15...	21.93	1.07	2.97	1.16	4.15	9.33	17.58	11.49	1:5.4
June 16 to 30..	22.17	1.27	3.52	1.21	4.47	9.30	18.50	12.14	1:4.7
July 1 to 15...	25.49	1.09	3.04	1.01	4.29	9.01	17.36	11.38	1:5.1

C.

Period.	Nutritive ratio. (Fats x 2¼.)	Per 1000 pounds live weight fed. Digestible prot'in. Lbs.	Digestible fibre. Lbs.	Digestible n.-free extr'ct. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
May 16 to 31..	1:6.3	1.87	2.51	7.29	.90	12.57	19.52	25504
June 1 to 15...	1:5.8	2.22	2.58	8.02	.97	13.79	21.10	27939
June 16 to 30..	1:4.7	2.71	2.63	8.08	.96	14.38	21.93	29012
July 1 to 15...	1:5.5	2.23	3.26	7.12	.83	13.44	20.51	26957

D.

Period.	Per cent. of ash in milk.	Per cent. of fat in milk.	Per cent. of casein and albumen in milk.	Per cent. of sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
May 16 to 31..	.66	4.03	3.73	5.23	.11	.67	.62	.87	2.27
June 1 to 15...	.75	4.10	3.76	5.20	.13	.71	.65	.90	2.39
June 16 to 30..	.70	3.66	3.43	4.31	.12	.63	.59	.74	2.08
July 1 to 15...	.72	4.10	3.68	5.01	.12	.68	.61	.83	2.24

E.

Period.	Total cost of food aver'ge per day per cow. Cents.	Milk yield aver'ge per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
May 16 to 31..	13.83	16.64	1.02	7.49	25.36	.83	6.09	20.64
June 1 to 15...	13.75	17.31	1.08	7.80	26.27	.79	5.75	19.37
June 16 to 30..	13.29	17.19	1.15	9.50	31.38	.77	6.39	21.10
July 1 to 15...	13.49	16.57	1.11	8.24	27.13	.81	6.02	19.84

in the preceding period. The grain represented 54.5 per cent. of the cost of the ration and supplied 36.2 per cent. of the digestible nutrients. The forage represented 21.7 per cent. of the cost of the ration and supplied 40.9 per cent. of the digestible nutrients.

From July 1st to 15th, inclusive, oat-and-pea forage was fed morning and noon and clover hay at night. The same grain was fed as during the preceding period. The grain represented 53.6 per cent. of the cost of the ration and supplied 38.7 per cent. of the digestible nutrients. The forage represented 22.8 per cent. of the cost of the ration and supplied 37.4 per cent. of the digestible nutrients.

For the fifteen days preceding May 16th the ration had been the same as it was from May 16th to May 31st. The cows gained in weight from 8 to 11 pounds on the average during each of the

first three periods. During the fourth period the loss in weight per cow is rated at from 4 to 5 pounds, although this loss is only estimated from the total loss during July, the cows not having been weighed until the 28th, after corn silage and alfalfa forage had been again fed.

The greatest amount of organic matter was in the ration for the third period when the largest amount of alfalfa was fed, and the cost of the ration was somewhat the lowest. The ration contained the largest amount of digestible protein and the nutritive ratio was the narrowest, that of 1:4.7. The cost of food for weight of milk produced was lowest during the third period and the cost of fat the highest. The greatest amount of digestible fat was contained in the ration for the second period and the most fat was produced in the milk. The cost of fat produced was lowest during the second period. During the third period the forage supplied a larger proportion of the digestible nutrients than during any other period—that of 40.9 per cent.—although the cost of the forage was but 21.7 per cent. of the cost of the ration. The grain at this time supplied but 36.2 per cent. of the digestible nutrients and represented 54.5 per cent. of the cost of of the ration.

For the first period the greatest daily average milk yield was 22.1 pounds and the smallest 11.5 pounds; the highest average per cent. of fat was 5.45 and the lowest 2.88 per cent. For the second period the greatest daily average milk yield was 22.6 pounds and the smallest 11.0; the highest average per cent. of fat was 5.71 and the lowest 2.76. For the third period the extremes in daily average milk yield were 23.9 pounds and 10.0 pounds; the extremes in average per cent. of fat were 6.17 and 2.80. For the fourth period the extremes were 23.8 pounds and 9.9 pounds of milk and 6.10 per cent. and 2.88 per cent. of fat.

The composition of each food used from May 15th to July 15th is shown in the following tabulated form.

	Per cent. of moisture.	Ash. Per cent.	Protein Per cent.	Crude fibre. Per cent.	Nitrogen free extract. Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage	77.6	1.0	3.0	5.4	11.5	1.5	2.11	——
Alfalfa forage	71.9	2.4	6.6	7.3	10.1	1.7	——	——
Oat and pea forage...	77.8	1.8	3.5	6.8	8.9	1.2	2.54	1.66
Mixed grain No. 16	13.5	4.4	16.5	7.9	52.8	4.9	3.06	2.85
Mixed grain No. 17	11.5	3.1	14.4	4.7	60.8	5.5	2.60	——
Mixed hay (May 16th to May 31st)..	15.5	5.6	11.2	29.7	33.7	4.3	2.12	1.80
Mixed hay (June 1st to June 30th)..	10.1	5.9	10.2	32.2	36.1	5.5	——	——
Clover hay (July 1st to July 15th).....	11.4	5.1	15.6	29.5	34.1	4.3	2.82	1.52

Table II gives the results obtained in feeding eight cows from August 1st to September 15th, 1891. On August 1st the average age of these cows was 2.9 years, and they had been in milk at that date on the average 5.3 months. From August 1st to August 15th, inclusive, alfalfa forage was fed in the morning. corn silage at noon and night, and a mixed grain (No. 19) consisting of five parts wheat bran, five parts corn meal, two parts wheat middlings and three parts linseed meal, N. P. The grain cost 53.4 per cent. of the cost of the ration and supplied 37.7 per cent. of the digestible nutrients. The silage and forage represented the smaller part of the total cost of the ration and supplied the larger part of the digestible nutrients.

From Aug. 15th to Aug. 31st, inclusive, corn silage was fed morning and night, timothy forage at noon, and the same mixed grain (No. 19) that was fed during the preceding period. The grain cost 53.8 per cent. of the total cost of ration and supplied 36.1 per cent. of the total digestible nutrients, the silage and forage representing 46.2 per cent. of the cost and supplying 63.9 per cent. of the digestible nutrients.

From Sept. 1st to Sept. 15th, inclusive, barley-and-pea forage was fed morning and night, hay at noon, and the same grain (No 19). The grain cost 51.2 per cent. of the total cost of the

TABLE II—A.

Period.	Avg. live wt. per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Timothy forage. Lbs	Mixed hay. Lbs.	Mixed grain No. 19. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Aug. 1 to 15..	824.8	51.22	29.89	13.92	——	——	6.62	50.43	17.33
Aug. 16 to 31.	851.8	50.13	26.23	——	18.47 Barley and pea forage.	——	6.63	51.33	17.45
Sept. 1 to 15..	866.2	59.33	——	——	32.47	6.34	6.63	45.44	19.88

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-Free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼).
Aug. 1 to 15..	33.10	1.54	2.49	.77	3.11	9.93	15.79	11.36	1:5.9
Aug. 16 to 31.	33.88	1.07	2.21	.84	3.36	9.97	16.38	11.87	1:6.9
Sept. 1 to 15..	25.56	1.21	3.13	.81	4.21	10.53	18.67	12.93	1:5.3

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N.-Free extract Lbs.	Digestible fat. Lbs.	Total digestible nutrients Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Aug. 1 to 15..	1:6.3	2.02	2.24	8.78	.73	13.77	19.14	27335
Aug. 16 to 31.	1:7.7	1.70	2.76	8.75	.73	13.94	19.23	27651
Sept. 1 to 15..	1:5.3	2.52	3.20	8.55	.66	14.93	21.55	29317

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per ct. casein and albumen in milk	Per cent. sugar in milk	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
Aug. 1 to 15..	.72	3.49	3.49	5.21	.13	.63	.63	.94	2.33
Aug. 16 to 31.	.69	3.88	3.56	4.94	.11	.62	.57	.79	2.09
Sept. 1 to 15..	.76	4.12	3.57	4.74	.11	.60	.52	.69	1.92

E.

Period.	Total cost of food avg. per day per cow. Cents.	Milk yield avg per day per cow. Lbs.	Pounds of water-free food consumed for one lb. of milk produced. Lbs.	Pounds of water-free food consumed for one lb of milk solids produced. Lbs.	Pounds of water-free food consumed for one lb. of fat produced. Lbs.	Cost of food for one lb of milk Cents.	Cost of food for one lb. of milk solids. Cents.	Cost of food for one lb. of fat in milk Cents.
Aug. 1 to 15..	12.60	18.05	.96	7.44	27.51	.70	5.41	20.00
Aug. 16 to 31.	12.52	15.98	1.09	8.35	28.15	.78	5.99	20.19
Sept. 1 to 15..	13.16	14.56	1.37	10.35	33.13	.90	6.85	21.93

ration and supplied 33.2 per cent. of the digestible nutrients. The forage represented 24.7 per cent. of the cost of the ration and supplied 45.6 per cent. of the digestible nutrients.

During each of the first two periods the cows gained in weight on the average about 27 pounds and during the last period the gain in weight was less, being about four pounds on the average per cow for the whole of September. In the change from the first period to the second, when timothy forage was substituted for alfalfa forage, there was considerably more than the normal decrease of milk yield although the total food consumed was about the same; the total organic matter, the total digestible nutrients and the fuel value being about the same—slightly increased. There was the same amount of digestible fat but considerably less digestible protein in the second ration; the nutritive ratio being changed from 1:6.3 to 1:7.7. The cost of the second ration was somewhat less but the cost of production of milk, and its constituents, was

somewhat more than for the first period. By a change to barley-and-pea forage and hay in the third ration there was an increase in the total organic matter of the ration, the amount of digestible nutrients, the digestible protein, and of the fuel value, although at a slight increase of cost. The nutritive ratio was made narrower—that of 1:5.3. There was considerable decrease in the milk yield, however, although not so much as followed the first change. The cost of milk, of the milk solids and fat, was somewhat greater for the third period.

The greatest daily average yield of milk for the first period was 30.3 pounds and the smallest 11.7 pound. The highest average per cent. of fat was 4.77 and the lowest 2.30 per cent. For the second period the extreme daily average milk yields were 26.7 pounds and 9.4 pounds, the extremes in average percentage of fat were 5.62 and 1.92 per cent. For the third period the extremes in daily aqerage yield of milk were 24.7 pounds and 8.7 pounds, and in average percentage of fat 5.28 and 2.83 per cent. The following table shows the composition of each food used during this trial :

	Per cent. moisture.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent	Nitrogen-free extract. Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage	74.1	1.2	2.2	6.0	15.5	1.0	1.35	1.19
Alfalfa forage	73.9	2.7	4.6	6.3	11.6	.9	2.83	2.09
Timothy forage	74.6	2.5	2.4	7.3	11.9	1.3	1.54	1.29
Barley and pea forage	74.1	1.9	4.2	6.8	12.0	1.0	2.61	2.05
Mixed hay	13.2	4.6	9.1	24.6	46.2	2.3	1 67	1.55
Mixed grain No. 19.	9.9	4.6	18.0	6.6	55.8	5.1	3.20	2.82

In Table III are compared the results obtained in three periods of feeding from September 1st to October 15th, 1891, with eight cows. The same cows were used as during the preceding trial, the results of which were given in Table II. The first period, from September 1st to 15th, is the same as the last period in the preceding group but the results are repeated for compari-

son. The cows had been in milk on the average 7.3 months by October 1st, and the average age was a little over three years.

In the second period from September 16th to September 30th alfalfa forage was substituted for the barley-and-pea forage of the preceding period—alfalfa forage being fed morning and night, and hay at noon and the same grain mixture (No. 19). The grain cost 53.6 per cent. of the cost of the ration and supplied 38.4 per cent. of the digestible nutrients. The forage represented 21.6 per cent. of the cost of the ration and supplied 37.3 per cent. of the digestible nutrients.

During the third period corn forage was fed morning and night and hay at noon. The mixed grain (No. 21) consisted of seven parts wheat bran, five parts ground oats, three parts corn meal, and three parts linseed meal, O. P. The grain cost 55 3 per cent. of the cost of the ration and supplied 32.4 per cent. of the total digestible nutrients. The forage represented 20.6 per cent. of the cost of the ration and supplied 46.1 of the total digestible nutrients.

The cows gained little in weight during the first two periods but much more during the third. In changing from the ration of the first period with barley-and-pea forage to that of the second with alfalfa forage, the nutritive ratio was made narrower—a change of from 1 : 5.3 to 1 : 4.5; the total digestible protein remained about the same, and the digestible fat was reduced somewhat. The total organic matter and total digestible nutrients in the second ration were also considerably less, and the fuel value was lower. The cost of the ration was lower; and the cost of milk, milk-solids and fat somewhat less. There was no falling off in the milk yield, but on the contrary a slight increase. The composition of the milk remained about the same, the slight change being toward improvement in quality. By substituting corn forage in the third period for alfalfa, and changing the grain, the nutritive ratio of the ration was made much wider that of 1 : 8.0. In the ration for the third period the total organic matter and the total digestible nutrients were increased together with a little increase in the cost of the ration; the fuel value was higher, the digestible fat remained about the same and the amount of protein was much less. The milk yield, however, was slightly increased. The cost of milk was the same and the cost of fat was a little higher.

TABLE III—A.

Period.	Avg. live wt. per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn forage. Lbs.	Alfalfa forage Lbs.	Barley and pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain. No. 19. Lbs.	Total food Lbs.	Total dry matter in food. Lbs.
Sept. 1 to 15..	866.2	59.33	——	——	32.47	6.34	6.63	45.44	19.88
Sept. 16 to 30	868.3	81.41	——	27.23	——	6.27	6.66	40.16	18.38
Oct. 1 to 15...	886.3	65.99	26.85	——	——	6.28	No. 21. 6.60	39.73	19.36

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N. free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible Nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Sept. 1 to 15..	25.56	1.21	3.13	.81	4.21	10.53	18.67	12.93	1:5.3
Sept. 16 to 30	21.78	1.36	3.19	.72	3.75	9.37	17.02	11.22	1:4.6
Oct. 1 to 15...	20.37	.82	2.17	.70	3.65	12.00	18.54	12.66	1:7.9

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N.-free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Sept. 1 to 15..	1:5.3	2.52	3.20	8.55	.66	14.93	21.55	29327
Sept. 16 to 30	1:4 6	2.46	2.15	7.72	.59	12.92	19.60	25424
Oct. 1 to 15...	1:8.0	1.67	2.53	9.52	.56	14.28	20.92	27882

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per ct. casein and albumen in milk	Per ct. sugar in milk	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
Sept. 1 to 15..	.76	4.12	3.57	4.74	.11	.60	.52	.69	1.92
Sept. 16 to 30	.75	4.21	3.60	5.03	.11	.62	.53	.74	2.00
Oct. 1 to 15...	.73	4.10	4.16	4.76	.11	.62	.63	.72	2.08

E.

Period.	Total cost of food avg. per day per cow. Cents.	Milk yield avg. per day per cow. Lbs.	Pounds of water-free food consumed for one lb. of milk produced. Lbs	Pounds of water-free food consumed for one lb. of milk solids produced. Lbs	Pounds of water-free food consumed for one lb. of fat produced. Lbs	Cost of food for one lb. of milk Cents.	Cost of food for one lb. of milk solids. Cents.	Cost of food for one lb. of fat in milk. Cents.
Sept. 1 to 15..	13.16	14.56	1.37	10.35	33.13	.90	6.85	21.93
Sept. 16 to 30	12.62	14.71	1.25	9.19	29.65	.86	6.31	20.35
Oct. 1 to 15...	13.01	15.14	1.28	9.31	31.23	.86	6.25	20.98

The greatest average daily yield of milk for the second period was 24.5 pounds and the smallest 9.0 pounds. The highest average per cent. of fat was 6.15 and the lowest 2.73 per cent. For the third period the extremes in milk yield were 25.1 pounds and 9.6 pounds and in percentage of fat 5.65 and 2.55 per cent.

The composition of each food used is shown in the following tabulated form. The analyses of the barley-and-pea forage, the mixed hay and of mixed grain (No. 19) are given on page 536.

	Moisture per cent.	Ash per cent.	Protein per cent.	Crude fibre per cent.	N.-Free extract per cent.	Fats per cent.	In water-free substance.	
							Total nitrogen per cent.	Albuminoid nitrogen per cent.
Alfalfa forage..	74.5	2.8	5.2	6.5	10.1	.9	3.26	2.68
Corn forage.....	69.9	1.0	2.1	5.9	20.1	1.0	1.12	1.09
Mixed grain No. 21.	11.7	4.0	15.7	8.1	56.1	4.4	2.85	2.68

TABLE IV—A.

Period.	Avg. weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Oat and pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 25. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
May 16 to 31..	868.3	70.32	15.90	——	——	10.80	5.84 No. 26.	32.54	19.37
June 1 to 30...	852.6	63.72	——	44.66	——	5.44	6.29	56.39	19.26
July 1 to 15...	859.9	61.13	——	——	50.08	5 38	6.21	61.67	23.42

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-Free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food. (Fats x 2¼.)
May 16 to 31..	13.17	1.11	2.40	.96	4.37	10.52	18.26	11.18	1:7.1
June 1 to 30...	37.13	1.39	2.69	1.17	4.33	9.68	17.87	11.91	1:6.2
July 1 to 15...	28.25	1.39	2.62	1.39	5.49	12.52	22.03	15.67	1:8.1

C.

Period.	N'tritive ratio. (Fats x 2¼.)	Per 1000 pounds live weight fed. Digestible prot'in. Lbs.	Digestible fibre. Lbs.	Digestible N.-free extr'ct. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
May 16 to 31..	1:7.1	1.72	2.58	7.79	.81	12.90	21.03	25906
June 1 to 30...	1:6.0	2.17	2.50	8.33	.97	13.97	20.96	28273
July 1 to 15...	1:8.0	2.19	4.42	10.45	1.16	18.22	25.62	36627

D.

Period.	Per cent ash in milk.	Per cent. fat in milk.	Per ct. casein and albumen in milk	Per cent. sugar in milk	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
May 16 to 31..	.67	4.09	3.18	5.99	.14	.85	.66	1.25	2 90
June 1 to 30...	.67	3.87	3.20	5.90	.14	.82	.68	1.25	2.89
July 1 to 15...	.74	3.61	3.15	5.80	.15	.75	.65	1.20	2.75

E.

Period.	Total cost of food. Avg. per day per cow. Cents.	Milk yield. Avg. p'r day per cow. Lbs.	Pounds of water-free food consumed for one lb. of milk produced. Lbs.	Pounds of water-free food consumed for one lb. of milk solids produced. Lbs.	Pounds of water-free food consumed for one lb. of fat produced. Lbs.	Cost of food for one lb. of milk Cents.	Cost of food for one lb. of milk solids Cents.	Cost of food for one lb. of fat in milk Cents.
May 16 to 31..	14.35	20.86	.93	6.68	22.79	.69	4.95	16.88
June 1 to 30...	14.91	21.20	.91	6.66	23.49	.70	5.16	18.18
July 1 to 15...	15.32	20.72	1.13	8.52	31.23	.74	5.57	20.43

In table IV are given the results obtained in a feeding trial from May 15 to July 15, 1892. During June alfalfa forage was fed, and for comparison with the results obtained then, those of the fifteen days preceding and for the fifteen days following are given. Fourteen cows were used in this feeding trial of the average age at its beginning of 3.4 years. They had been in milk on the average 3.6 months when the trial began.

From May 16th to 31st, inclusive, corn silage was fed at noon, mixed hay morning and night and a mixed grain (No. 25)—consisting of six parts wheat bran, two parts ground oats, two parts wheat middlings, one part linseed meal, O. P. and three parts cotton-seed meal. The same ration had also been fed for the first part of the month. Of the cost of the ration 45.8 per cent. was represented by the grain, 16.6 per cent. by the silage. Of the total digestible nutrients the grain supplied 32.1 per cent. and the silage 26.0 per cent.

From June 1st to June 30th alfalfa forage was fed morning and noon, hay at night, and a mixed grain (No. 26) which consisted of six parts ground oats, three parts corn meal, and two parts cotton-seed meal. Of the cost of the ration the grain represented 51.8 per cent. and the forage 30.0 per cent. The grain supplied 34.6 per cent. of the digestible nutrients and the forage supplied 45.6 per cent.

From July 1st to July 15th the oat-and-pea forage was fed morning and noon and hay at night. The same kind of mixed grain was fed as during June. The grain represented 49.7 per cent. of the cost of the ration and the forage 32.7 per cent. The grain supplied 26.0 per cent. of the digestible nutrients and the forage 59.1 per cent.

During the first period the cows lost in weight an average of over 15 pounds. During the second an average of 16 pounds, and gained during the third about 30 pounds on the average. For the first period the greatest daily average milk yield was 30.7 pounds and the smallest 14.5 pounds. The highest average per cent. of fat was 5.85 and the lowest 3.28 per cent. For the second period the extremes in daily average milk yield were 32.0 pounds and 12.0 pounds, and the extremes in average percentage of fat were 6.18 and 2.98. For the third period the extremes were 31.3 pounds and 12.9 pounds and 5.02 per cent. and 2.47 per cent.

In changing from the ration of the first period to that of the second the nutritive ratio was changed from 1:7.1 to 1:6.0 although a larger amount of a less nitrogenous grain was fed in the second ration. The cost of the ration was somewhat greater in the second period owing to the rather costly grain mixture used. The total dry matter and organic matter in the ration remained about the same, although there was an increase in total digestible nutrients. There was an increase of the protein and of the fat in the second ration, and the fuel value was higher. The yield of milk increased somewhat; but the amount of the different constituents remained the same although there was a slight decrease in the per cent. of fat. The cost of milk was about the same as for the first period and the cost of fat somewhat higher.

In the third period oat-and-pea forage was substituted for the alfalfa of the second making the nutritive ratio much wider, although the same kind of grain was fed and the same kind of

hay. In the ration for the third period there was considerable increase of the total dry matter, the digestible nutrients, and of the fuel value, the cost also being increased. There was considerably more digestible fat and about the same amount of protein. There was about the normal decrease in milk yield, but accompanied by a slight falling off in total solids, more noticeable in the per cent. of fat. The cost of milk and fat production was greater in the third period. In the following tabulated form will be found the composition of the different foods used in this trial.

	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N-free extract. Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Corn silage.....	71.0	1.0	2.5	5.4	18.4	1.5	1.40	1.03
Alfalfa forage..	80.1	2.0	2.8	5.2	8.5	1.4		
Oat-and-pea forage ...	73.7	1.8	2.4	7.0	13.4	1.7		
Mixed hay.....	11.7	5.9	7.9	29.2	41.9	3.4	1.43	1.32
Mixed grain No. 25...	10.7	4.8	19.7	6.2	52.6	6.0	3.53	3.52
Mixed grain No. 26...	11.5	2.8	16.0	6.6	57.3	5.8		

In table V. are shown the results obtained during August, 1892, in feeding alfalfa forage and oat-and-pea forage. Ten cows were used in this trial of 3.5 years average age August 1st, at which time they had been in milk on the average about 4 months. The same hay and grain were fed throughout the trial—alfalfa forage was fed during the first part and oat-and-pea forage during the latter part. From August 1st to 13th, inclusive, alfalfa forage was fed morning and noon, hay at night, and a mixed grain (No. 27) consisting of five parts wheat bran, two parts ground oats, three parts corn meal, and two parts linseed meal N. P. The grain represented 48.1 per cent. of the cost of the ration and supplied 30.2 per cent. of the digestible nutrients. The forage represented 34.2 per cent. of the cost of the ration and supplied 53.3 per cent. of the digestible nutrients.

TABLE V—A.

Period.	Average live weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Alfalfa forage. Lbs.	Oat-a'd-pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 27. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Aug. 1 to 13...	862.0	73.56	48.99	——	5.09	6.62	60.70	22.34
Aug. 14 to 31..	854.0	62.65	——	47.15	5.08	6.78	59.01	19.58

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	Nitrogen-free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food. (Fats x 2¼).
Aug. 1 to 13...	38.36	1.67	2.77	1.31	5.27	11.32	20.67	13.75	1:7.1
Aug. 14 to 31..	39.43	1.15	2.18	1.20	4.34	10.70	18.43	12.88	1:8.1

C.

Period.	Nutritive ratio (Fats x 2¼).	Per 1000 pounds live weight fed. Digestible protein. Lbs.	Digestible fibre. Lbs.	Digestible N.-free extr't. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Aug. 1 to 13...	1:6.8	2.20	3.09	9.64	1.02	15.95	23.98	32074
Aug. 14 to 31..	1:7.8	1.85	3.37	8.90	.96	15.08	21.58	30314

D.

Period.	Per cent. of ash in milk.	Per cent. of fat in milk.	Per cent of casein and albumen in milk.	Per cent. of sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Aug. 1 to 13...	.61	3.71	3.21	5.14	.13	.81	.70	1.12	2.76
Aug. 14 to 31..	.60	3.82	3.28	5.53	.12	.73	.63	1.06	2.54

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Average per day per cow. Lbs.	Pounds of water-free food c'ns'med for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat in milk. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Aug. 1 to 13...	14.34	21.71	1.03	8.09	27.58	.66	5.20	17.70
Aug. 14 to 31..	14.31	19.18	1.03	7.71	26.82	.75	5.63	19.60

From Aug. 14th to Aug. 31st, oat-and-pea forage was fed morning and noon, hay at night, and the same mixed grain as before. The grain represented 49.3 per cent. of the cost of the ration and the forage 32.9 per cent. The grain supplied 33.0 per cent. of the digestible nutrients and the forage 49.4 per cent. There was an average loss of weight during the whole month of 16 pounds.

In changing from alfalfa to oat-and-pea forage the nutritive ratio of the ration was made wider. There was a slight diminution in the amount of total digestible nutrients and in the fat, and considerable in the amount of protein. The fuel value of the ration was somewhat less. The cost of the ration was practically the same for both periods. In the second period there was considerable falling off in the milk yield, and in the amount of

the milk constituents, although there was a slight improvement in the quality of the milk. The cost of milk and solids was increased.

The highest daily average milk yield for the first period was 28.8 pounds and the lowest 14.81 pounds. The highest average percentage of fat was 4.80 and the lowest 2.70 per cent. For the second period the extremes in daily average yield were 27.48 pounds and 13.63 pounds, and in percentage of fat 5.10 and 2.48 per cent.

The following table shows the composition of each food used:

	Moisture. Per cent.	Ash. Per cent	Protein. Per cent.	Crude fibre. Per cent.	N-free extract. Per cent.	Fats. Per cent.
Alfalfa forage.....	75.5	2.4	3.0	6.8	10.7	1.6
Oat-and-pea forage.....	80.7	1.4	1.8	5.1	9.6	1.4
Mixed hay.	11.5	4.6	5.3	29.0	45.4	4.2
Mixed grain No. 27	11.8	3.9	15.6	6.9	57.0	4.8

The results obtained in a feeding trial from Sept. 1st to Oct. 15th, 1892, are shown in table VI. There was a change from oat-and-pea forage to alfalfa forage, and from alfalfa to corn silage. Ten cows were used in this trial of the average age, Sept. 1st, of 3.9 years, and had been in milk on the average, at that time, about five months.

From Sept. 1st to 15th, oat-and-pea forage was fed morning and noon, hay at night, and a mixed grain, No. 27, consisting of five

TABLE VI—A.

Period.	Avg. weight per cow during period. Lbs.	Average per day per cow.							
		Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Oat and pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 27. Lbs	Total food. lbs.	Total dry matter in food. lbs.
Sept. 1 to 15..	877.0	56.63	——	——	52.07	5.54	7.42	65.03	21.89
Sept. 16 to 30	885.5	72.53	——	41.45	——	5.69	7.48	54.62	20.34
Oct. 1 to 15...	898.0	60.40	37.57	——	——	5.85	No. 28. 7.39	50.75	22.77

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fat in food. Lbs.	Crude fibre in food. Lbs.	N.-free extract in food. Lbs.	Total organic matter in food Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food (Fats x 2½)
Sept. 1 to 15..	43.14	1.27	2.39	1.32	4.78	11.75	20.62	14.18	1:8.2
Sept. 16 to 30	34.28	1.59	3.21	1.18	4.20	10.16	18.75	12.44	1:5.3
Oct. 1 to 15...	27.98	1.03	2.60	1.31	4.57	13.26	21.74	14.04	1:8.0

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N.-free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Sept. 1 to 15..	1:7.8	1.98	3.63	9.52	1.04	16.17	23.51	32531
Sept. 16 to 30	1:5.1	2.51	2.35	8.29	.90	14.05	21 17	28257
Oct. 1 to 15...	1:8.3	1.84	2.80	9.88	1.12	15.64	24.21	31734

D.

Period.	Per cent. ash in milk.	Per cent fat in milk	Per ct. casein and albumen in milk	Per cent. sugar in milk.	Average per day per cow. Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
Sept. 1 to 15..	.55	3.49	3.08	5.61	.11	.69	.61	1.11	2.52
Sept. 16 to 30	.56	3.26	3.19	5.36	.11	.65	.63	1.06	2.45
Oct. 1 to 16...	.67	3.82	3 21	5.26	.13	.72	.61	.99	2.45

E.

Period.	Total cost of food Avg.p'r day per cow. Cents.	Milk. Avg.p'r day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat in milk. Lbs.	Cost of food for one lb. of milk Cents.	Cost of food for one lb. of milk-solids. Cents.	Cost of food for one lb. of fat in milk Cents.
Sept. 1 to 15..	15.71	19.70	1.11	8.69	31.72	.80	6.23	22.77
Sept. 16 to 30	14.77	19.74	1.03	8.30	31.29	.75	6.03	22.72
Oct. 1 to 15...	17.09	18.75	1.21	9.29	31.63	.91	6.98	23.74

parts wheat bran, two parts ground oats, three parts corn meal and two parts linseed meal, N. P. The grain cost 49.2 per cent. of the cost of the ration and supplied 32.8 per cent. of the digestible nutrients. The forage represented 33.2 per cent. of the cost of the ration and supplied 49.7 per cent. of the digestible nutrients.

From Sept. 16th, to 30th, inclusive, alfalfa forage was fed morning and noon and hay at night. The same mixed grain was fed as during the preceding period. The cost of the grain was 52.7 per cent. of the cost of the ration and 37.7 per cent. of the digestible nutrients were supplied by the grain. The forage represented 28.0 per cent. of the cost of the ration and supplied 41.9 per cent. of the digestible nutrients.

From Oct. 1st to 15th corn silage was fed morning and noon and hay at night. A mixed grain, No 28, was fed consisting of five parts wheat bran, three parts ground oats, two parts linseed meal, O. P., and two parts of cotton-seed meal. The grain represented 49.8 per cent. of the cost of the ration and supplied 30.1 per cent. of the total digestible nutrients. The silage represented 33.1 per cent. of the cost of the ration and supplied 51.2 per cent. of the total digestible nutrients. There was an average gain in live weight of 17 pounds, during the whole of Sept. and an average gain from Oct. 1st to 15th of about 16 pounds.

In changing from oat-and-pea forage to alfalfa forage the nutritive ratio of the ration was made much narrower. There was less fat in the second ration and more protein; the total digestible nutrients were less and the fuel value was lower. There was a decrease in the total cost of the food but the milk yield remained about the same. The per cent. of fat in the milk was less. The cost of production was lower for milk and for total solids. The cost of fat produced was almost exactly the same. In changing from alfalfa forage to corn silage, although there was also some change in the grain, the nutritive ratio was made much wider, a change of from 1:5.1 to 1:8.3. There was an increase of total organic matter, total digestible nutrients, and fat, but the protein was much less. There was considerable increase in the cost of the ration and the fuel value was increased. There was a fairly normal decrease in the milk yield. There was an increase in the per cent. and in the amount of fat. The cost of milk, milk solids,

and fat, was greater than for the third period. From Sept. 1st to 15th the greatest daily average milk yield was 34.2 pounds and the smallest 12.4 pounds. The highest average per cent. of fat was 5.00 and the lowest 2.50. From Sept. 16th to 30th the extremes were 36.7 pounds and 11.6 pounds of milk and 5.20 per cent. and 1 08 of fat. From Oct. 1st to 15th the extremes were in milk yield 34.5 pounds and 10.6 pounds and in percentage of fat 5.90 and 2.40 per cent. The composition of the hay fed during this trial, of the oat-and-pea forage and of the mixed grain, No. 27, will be found on page 546. The composition of each of the other foods is shown in the following table:

	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N-free extract Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Alfalfa forage.....	79.0	2.5	4.2	4.9	8.0	1.4	3.21	2.63
Corn silage..	69.7	1.2	2.7	5.7	18.9	1.8	1.44	1.26
Mixed grain, No. 28..	15.3	4.2	17.5	10.0	47.8	5.2	3.31	3.06

The results obtained in a feeding trial from May 17th to July 15, 1893, are shown in table VII. There was a change from corn silage to rye and alfalfa forage, then to alfalfa forage and finally to oat and pea forage. Ten cows were used of the average age June 1st of 4.8 years. They had been in milk at that date about 4.5 months.

From May 17th to May 31st, inclusive, corn silage was fed morning and noon and hay at night. The grain fed, No. 31, consisted of six parts wheat bran, one part ground oats, two parts corn meal, two parts wheat middlings, one part linseed meal, O. P., and one part cotton-seed meal. This same ration had been fed for several weeks preceding. The cost of grain was 45.4 per cent. of the cost of the ration and the grain supplied 40.2 per cent. of the digestible nutrients. The silage represented 35.6 per cent. of the cost of the ration and supplied 35.5 per cent. of the digestible nutrients.

TABLE VII—A.

Period.	Avg. live wt. per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage. Lbs.	Oat-and-pea forage Lbs.	Mixed hay. Lbs.	Mixed grain No 31. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
May 17 to 31..	942.2	64.16	36.15 Rye forage.	——	——	5.78	6.65 No. 32.	48.58	19.56
June 1 to 10...	934.8	73.26	17.83	20.48	——	6.08	6.96	51.35	19.86
June 11 to 30..	936.2	78.27	——	48.75	——	5.41	6.86	61.02	21.32
July 1 to 15...	937.5	66.82	——	——	54.56	5.06	7.49	67.11	19.50

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-free extract in food Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in foods (Fats x 2¼).
May 17 to 31..	29.02	.99	2.47	1.15	3.71	11.23	18.57	10.01	1:7.1
June 1 to 10...	31.49	1.20	2.66	1.05	4.73	10.24	18.66	12.64	1:6.5
June 11 to 30..	39.70	1.49	3.20	1.18	5.00	10.48	19.83	13.16	1:5.7
July 1 to 15...	47.61	1.34	3.07	1.08	4.15	9.89	18.16	12.77	1:5.4

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N.-free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
May 17 to 31..	1:6.5	1.56	2.22	5.94	.90	10.62	19.71	21877
June 1 to 10...	1:6.6	1.89	2.98	7.91	.74	13.52	19.96	26894
June 11 to 30..	1:5.7	2.26	2.70	8.26	.83	14.05	21.18	28091
July 1 to 15...	1:5.4	2.30	2.94	7.59	.79	13.62	19.37	27198

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk.	Per cent. sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
May 17 to 31..	.66	4.47	3.96	5.12	.16	1.10	.97	1.26	3.49
June 1 to 10...	.57	4.39	3.69	5.15	.13	1.01	.85	1.19	3.18
June 11 to 30.	.61	4.42	3.89	5.08	.14	1.00	.88	1.14	3.16
July 1 to 15...	.63	4.28	3.91	5.15	.14	.97	.89	1.17	3.12

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
May 17 to 31..	15.21	24.53	.76	5.60	17.78	.62	4.35	13.83
June 1 to 10...	13.75	23.05	.86	6.25	19.66	.60	4.32	13.61
June 11 to 30.	14.45	22.53	.95	6.75	21.32	.64	4.57	14.45
July 1 to 15...	15.48	22.69	.86	6.25	20.10	.68	4.96	15.96

From June 1st to June 10th alfalfa forage was fed in the morning, rye forage at noon and hay at night. The mixed grain, No. 32, consisted of five parts wheat bran, one part ground oats, four parts corn meal, one part wheat middlings and one part linseed meal, N. P. The grain represented 50.6 per cent. of the cost of the ration and the forage 27.3 per cent. The grain supplied 34.5 per cent. of the total digestible nutrients and the forage, 45.2 per cent.

From June 11th to June 30th, inclusive, alfalfa forage was fed in the morning and at noon and hay at night. The same mixed grain, No. 32, was fed. The grain represented 47.5 per cent. of the cost of the ration and the forage 33.7 per cent. The grain supplied 32.7 per cent. of the total digestible nutrients and the forage supplied 49.8 per cent.

From July 1st to 15th oat-and pea-forage was fed in the morning and at noon and a mixed hay at night. Mixed grain, No. 32, was again fed. The grain represented 48.4 per cent. of the cost of the ration and the forage 35.3 per cent. The grain supplied 36.7 per cent. of the total digestible nutrients and the forage 46.2 per cent. There was an average loss in weight during the first period of 16.5 pounds and a slight average gain during each of the other three periods of a little over one pound.

The ration for the second period had almost the same nutritive ratio as that of the first. There was a considerably greater amount of total digestible nutrients in the second ration, although the total organic matter was about the same. The fuel value of the second ration was higher and the cost was less. There was a greater amount of protein and less fat. There was about a normal decrease in milk yield. The cost of milk and of fat was about the same for both periods. The nutritive ratio was made somewhat narrower when rye forage was discontinued and more alfalfa fed; the total organic matter and the digestible nutrients were somewhat increased, also the fuel value and the cost of the ration. There was considerable increase in the amount of protein. There was a slight decrease in the milk yield, probably less than the normal. The milk and its fat cost somewhat more. In changing from alfalfa to oat-and-pea forage more forage and grain were fed; the amount of digestible protein remained about the same, but there was a little falling off in the total nutrients. The cost of the ration was somewhat greater, also the cost of the milk and fat—although there was no falling off in milk yield.

For the first period the greatest daily average milk yield was 35.3 pounds and the smallest 15 lbs. The highest average per cent. of fat was 6.47 and the lowest 3.05 per cent. For the second period the extremes in average daily milk yield were 34.9 pounds and 13.2 pounds and in percentage of fat 6.30 and 3.00 per cent. For the third period the extremes were 35.3 pounds and 12.7 pounds of milk, and 6.25 and 3.00 per cent of fat. For the fourth period the extremes were 35.5 pounds and 13.1 pounds, and 6.15 per cent. and 2.77 per cent. of fat. In the following table will be found the composition of each food used.

	Moisture Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	N-free extract. Per cent.	Fat. Per cent.	In water free substance. Total nitrogen. Per cent.	In water free substance. Albuminoid nitrogen. Per cent.
Corn silage	75.4	1.2	2.5	4.9	14.4	1.6	1.59	1.06
Rye forage	76.9	1.4	2.5	7.8	10.2	1.3	1.73	1.49
Alfalfa forage	77.9	2.0	3.8	6.5	8.4	1.4	2.72	2.17
Oat-and-pea forage	84.2	1.5	3.1	4.2	5.9	1.1	3.14	2.23
Mixed hay (May 17th to June 30th)	14.5	4.9	9.0	27.2	39.5	4.9	1.69	1.58
Mixed hay (July 1st to 31st)	12.6	5.1	8.7	28.6	40.4	4.6	1.60	1.50
Mixed grain, No. 31.	13.8	4.2	15.8	5 6	56.3	4.3	2.93	2.82
Mixed grain No. 32	13.7	3.5	12.5	5.2	61.8	3.3		
Alfalfa forage, (fed July 16th to 31st)	74.9	2.2	4.3	7.9	9.3	1.4	2.73	2.06

The results obtained with nine cows during July 1893 are given in table VIII. The average age of the cows was 4.9 years and the average time in milk 4.2 months. For the first half of the month oat-and pea forage was fed and for the latter half alfalfa forage. There was no change in the kind of hay or of grain throughout the month. Not quite so much hay or grain was fed with the alfalfa as with the oat-and-pea forage which made the cost of the ration somewhat lower. Forage was fed in the morning and at noon, and hay at night;—for the first period oat-and-pea forage and for the second alfalfa forage. The mixed grain, No. 32, consisted of five parts wheat bran, one part ground oats, four parts corn meal, one part wheat middlings and one part linseed meal, N. P. The grain represented 49.9 per cent. of the cost of the first ration and 48.9 per cent. of the cost of the second, and supplied 38.2 per cent. of the total digestible nutrients in the first and 29.9 per cent. in the second ration. The oat-and-pea forage represented 34.0 per cent. of the cost of the first ration and supplied 45.1 per cent. of the total digestible nutrients. The alfalfa forage represented 34.6 per cent. of the cost of the second ration and supplied 51.6 per cent. of the total digestible nutrients. There was an average gain in weight during the trial of a little more than six pounds.

TABLE VIII—A.

Period.	Average live weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Alfalfa forage. Lbs.	Oat-and-pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 32. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
July 1 to 15.....	913.2	70.12	——	53.93	5.05	7.89	66.87	19.74
July 16 to 31.....	916.6	87.29	52.08	——	4.95	7.35	64.38	23 43

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N-free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fat x 2¼.)
July 1 to 15...	47.13	1 35	3.10	1.08	4.12	10.10	18.39	12.95	1:5.4
July 16 to 31..	40.95	1.79	3.80	1.31	5.91	12.35	21.64	15.37	1:5.6

C.

Period.	Nutritive ratio	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N-free extract. Lbs.	Digestible. fat. Lbs.	Total digestible nutrients Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
July 1 to 15...	1:5.3	2.40	3.00	7.98	.80	14.18	20.14	28263
July 16 to 31..	1:5.6	2.72	3.29	9.83	.93	16.77	23.61	33387

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk.	Per cent. sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
July 1 to 15...	.64	4.26	3.83	5.20	.16	1.09	.98	1.33	3.56
July 16 to 31..	.60	4.20	3.79	5.13	.14	.97	.87	1.18	3.16

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Aver'ge per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids produced. Cents.	Cost of food for one pound of fat in milk. Cents.
July 1 to 15...	15.81	25.64	.77	5.54	18.11	.62	4.44	14.50
July 16 to 31..	15.04	23.02	1.02	7.41	24.15	.65	4.76	15 51

The second ration contained a little more protein and fat and considerably more of total nutrients; the fuel value was higher, and the nutritive ratio nearly the same—a trifle wider. There was somewhat more than the normal falling off in the milk yield. The milk and the fat cost a little more for the second period than for the first. From July 1st to 15th the highest daily average milk yield was 35.5 pounds and the lowest 18.4 pounds. The highest average per cent. of fat was 5.60 per cent. and the lowest 2.77 per cent. From July 16th to 31st the extremes in milk yield were 32.9 and 15.5 pounds and in percentage of fat 5.80 and 2.85 per cent. In the small table on page 553 will be found the composition of each food used in this trial.

The results obtained from the same nine cows later in the season during a trial in which corn forage and alfalfa forage in one ration were substituted for oat-and-pea forage and part of the hay in the other are shown in table IX. The cows averaged in

TABLE IX—A.

Period.	Average weight per cow during period Lbs.	Average per day per cow. Water. Lbs.	Corn forage. Lbs.	Alfalfa forage. Lbs.	Oat and pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 34. Lbs.	Total food. Lbs.	Total dry matter in food Lbs.
Aug. 17 to 31..	926.5	92.81	——	——	27.74	12.14	8.03	47.91	22.87
Sept. 1 to 15..	933.1	75.41	28.74	24.82	——	5.64	7.26	66.46	25.59

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N-free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fat x 2¼.)
Aug. 17 to 31..	25.04	1.59	3.45	1.58	5.37	10.92	21.28	13.98	1:5.8
Sept. 1 to 15..	40.87	1.30	3.29	1.63	5.32	14.07	24.29	16.92	1:7.0

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre Lbs.	Digestible N-free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Aug. 17 to 31.	1:5.8	2.51	3.22	8.77	1.19	15.69	22.97	31992
Sept. 1 to 15..	1:6.8	2.52	3.33	11.04	1.24	18.13	26.03	36048

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk.	Per cent. sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Aug. 17 to 31.	.62	4.65	3.92	5.10	.13	1.00	.85	1.10	3.08
Sept. 1 to 15..	.60	4.49	3.93	5.18	.14	1.05	.92	1.21	3.32

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Aver'ge per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Aug. 17 to 31	18.08	21.57	1.06	7.43	22.87	.84	5.87	18.08
Sept. 1 to 15.	16.51	23.30	1.10	7.71	24.37	.71	4.97	15.72

age a little over five years at the time of this feeding trial and had been in milk on the average about 5.6 months.

During the first period mixed clover hay was fed morning and night and oat-and-pea forage at noon. The mixed grain fed, No. 34, consisted of five parts wheat bran, two parts ground oats, five parts corn meal, one part wheat middlings, one part linseed meal O. P., one part cotton-seed meal, one part ground flaxseed, and four parts gluten feed. The grain represented 51.1 per cent. of the cost of the ration and supplied 38.4 per cent. of the total digestible nutrients. The forage represented 15.4 per cent. of the cost of the ration and supplied 24.2 per cent. of the digestible nutrients. During the second period alfalfa forage was fed in the morning, mixed hay (very little clover) was fed at noon and corn forage at night. No change was made in the grain. The grain represented 50.5 per cent. of the cost of the ration and and supplied 28.7 per cent. of the digestible nutrients. The forage repre-

sented 32.4 per cent. of the cost of the ration and supplied 56.8 per cent. of the total digestible nutrients. There was a small average gain in live weight during each period.

The second ration, having somewhat the wider nutritive ratio, contained the same amount of protein as the first, but more fat, considerably more total nutrients, and was considerably higher in fuel value. The cost of the second ration was somewhat lower. There was considerable increase in the average milk yield for the second period and the milk and fat cost less—although there was a slight decrease in average per cent. of fat in the milk. The extremes in daily average milk yield for the first period were 30.2 pounds and 12.8 pounds and in percentage of fat 6.10 and 2.80 per cent. The extremes for the second period were 31.9 and 16.2 pounds average daily milk yield, and 6.70 and 2.90 average per cent. of fat. The foods used showed the composition given in the following table:

	Moisture. Per cent.	Ash. Per cent.	Protein Per cent.	Crude fibre. Per cent.	N-free extract Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Oat and pea forage ...	81.8	2.3	4.0	4.4	6.2	1.4	3.47	2.44
Corn forage.....	73.4	1.1	2.2	4.9	17.0	1.4	1.34	1.15
Alfalfa forage.....	73.3	2.0	4.7	7.5	10.9	1.6	2.81	2.15
Mixed hay (Aug. 17th to 31st).....	12.4	5.7	8.4	30.0	39.1	4.5	1.53	1.44
Mixed hay (Sept. 1st to 15th)	14.5	4.3	5.2	28.2	43.4	4.5	.98	.93
Mixed grain No. 34...	10.5	3.3	16.5	6.3	55.4	8.0	2.95	2.92

The results of a feeding trial during May, 1894, are given in table X. Nine cows were used of the average age of 4.7 years. The average time they had been in milk by May 1st was 4.4 months. With one kind of grain fed throughout, there was a change from corn silage and hay to more of alfalfa forage and less hay, with an interval of five days in which both silage and forage were fed with the hay. For some weeks preceding this trial the ration had been very similar to that fed for the first period here reported.

For the first period corn silage was fed at noon, clover hay morning and night and a mixed grain, No. 38, consisting of five parts wheat bran, two parts corn meal, one part wheat middlings, one part cotton-seed meal and one part gluten feed. The grain cost 41.6 per cent. of the cost of the ration and supplied 33.9 per cent. of the total digestible nutrients. The silage represented 21.4 per cent. of the cost of the ration and supplied 24.7 per cent. of the total digestible nutrients.

For the second short period corn silage was fed in the morning, alfalfa forage at noon and clover hay at night. The grain cost 44.1 per cent. of the cost of the ration and supplied 34.3 per cent. of the total digestible nutrients. The silage and forage represented 33.3 per cent. of the cost and supplied 42.6 per cent. of the digestible nutrients. For the third period alfalfa forage was fed morning and noon, clover hay at night, and the same grain, No. 38, was fed. The grain represented 43.5 per cent. of the cost of the ration and supplied 30.3 per cent. of the total digestible nutrients. The forage represented 33.7 per cent. of the cost of the ration and supplied 48.0 per cent. of the total digestible nutrients. There was considerable average loss in weight during each period. The average loss in weight per cow for the month being 38.7 pounds.

The ration for the last period had a much narrower ratio than that of the first. There was an increase in the amount of digestible protein, fat and total nutrients, and the fuel value was higher. The cost of the ration was somewhat lower. The milk yield for the last period was about the same with a slight improvement in quality. The cost of milk and fat was less. The results in the short intermediate period were somewhat better than in the first or last. For the first period the greatest daily average milk yield was 34.9 pounds and the smallest 19.2 pounds. The highest average per cent. of fat was 7.00 and the lowest 3.05 per cent. For the second period the extremes were 36.1 pounds and 15.7 pounds in milk yield and 6.72 and 3.00 in average per cent. of fat. For the third period the extremes in daily average milk yield were 29.1 pounds and 15.2 pounds and in the average percentage of fat 6.45 and 3.10 per cent.

TABLE X—A.

Period.	Average live-weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Corn silage. Lbs.	Alfalfa forage Lbs.	Mixed clover. Lbs.	Mixed grain No 38. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
May 1 to 10.....	997.5	81.89	22.99	——	11.95	6.79	41.73	21.50
May 11 to 15.....	987.0	69.77	20.29	19.76	6.62	6.81	53.48	20.44
May 16 to 31.....	974.0	53.23	——	49.88	6.72	6.49	63.09	22.15

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-Free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food (Fats x 2¼).
May 1 to 10...	20.23	1.22	2.65	.84	5.81	11.96	20.28	12.53	1:7.4
May 11 to 15..	33.04	1.37	3.17	.94	4.05	10.91	19.07	12.44	1:5.4
May 16 to 31"	40.94	1.82	4.28	1.12	4.31	10.62	20.33	13.42	1:4.1

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible prot'in. Lbs.	Digestible fibre. Lbs.	Digestible N-free extr'ct. Lbs.	Digestible fat. Lbs.	Total digestible nutrients Lbs.	Total organic matter in food. Lbs.	Calories of energy in ration. Cal.
May 1 to 10...	1:7.4	1.58	2.50	7.86	.62	12.56	20.34	24825
May 11 to 15..	1:5.5	2.09	2.16	7.66	.70	12.61	19.32	25107
May 16 to 31..	1:4.0	2.96	2.20	7.83	.79	13.78	20.87	27495

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk	Per cent. sugar in milk	Average per day per cow. Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
May 1 to 10..	.63	4.25	3.79	5.11	.14	.96	.85	1.15	3.10
May 11 to 15..	.63	4.47	3.62	4.36	.16	1.11	.90	1.08	3.25
May 16 to 31..	.61	4.45	3.87	5.19	.14	1.00	.87	1.17	3.18

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Average per day per cow. Lbs.	Pounds of water-free food consumed for one pound milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids produced. Lbs.	Pounds of water-free food for one pound fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk. Cents.
May 1 to 10...	16.13	22.51	.96	6.94	22.40	.72	5.20	16.80
May 11 to 15..	15.07	24.81	.82	6.29	18.41	.61	4.64	13.58
May 16 to 31..	14.78	22.44	.99	6.96	22.15	.66	4.65	14.78

In the following table is found the composition of each food used:

	Mois. ture. Per cent.	Ash. Per cent.	Protein Per cent.	Crude fibre. Per cent.	N-free extract. Per cent.	Fats. Per cent.	In water-free substance. Total nitrogen per cent.	In water-free substance. Albuminoid nitrogen. Per cent.
Corn silage.....	77.9	1.4	2.0	4.8	13.1	.8	1.45	.97
Alfalfa forage	78.8	2.4	5.2	4.1	8.3	1.2	3.89	2.92
Clover hay.....	12.4	5.3	8.6	27.3	44.1	2.3	1.57	1.40
Mixed grain, No. 38..	12.3	4.0	17.1	6.7	54.2	5.7	3.12	2.83

The results of another feeding trial in which eight cows were fed from June 1st to July 31st 1894 are given in table XI. Alfalfa forage was fed during June and oat-and-pea forage during July

mixed clover hay during both months, and one kind of mixed grain. From June 1st to 30th alfalfa forage was fed morning and noon and clover hay at night. The mixed grain, No. 39, consist-

TABLE XI—A.

Period.	Average live weight per cow during period. Lbs..	Average per day per cow.						
		Water. Lbs.	Alfalfa forage. Lbs.	Oat-and-pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 39. Lbs.	Total food.	Total dry matter in food. Lbs.
June 1 to 30...	995.6	82.63	53.36	——	6.35	6.27	65.98	24.38
July 1 to 31...	1002.4	89.03	——	52.28	6.11	5.97	64.36	27.76

B.

Period.	Average per day per cow.								
	Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N-free extract in food. Lbs.	Total organic matter in food. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fat x 2¼.)
June 1 to 30..	41.60	1.59	3.24	1.00	5.72	12.85	22.79	15.17	1:6.4
July 1 to 31...	36.60	1.49	3.51	1.06	6.08	15.61	26.27	18.68	1:6.9

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight.						
		Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N-free extract Lbs.	Digestible fat. Lbs.	Total digestible nutrients Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
June 1 to 30...	1:6.6	2.12	2.91	9.52	.68	15.23	22.89	29933
July 1 to 31...	1:7.0	2.44	4.28	11.17	.74	18.63	26.21	36398

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk.	Per cent. sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
June 1 to 30...	.61	3.88	3.76	5.24	.17	1.06	1.03	1.43	3.69
July 1 to 31...	.61	3.77	3.59	5.25	.15	.96	.91	1.33	3.35

E.

Period.	Total cost of food. Average per day per cow. Cents.	Milk yield. Average per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
June 1 to 30...	14.67	27.32	.89	6.61	23.00	.54	3.98	13.84
July 1 to 31...	14.20	25.38	1.09	8.29	28.92	.56	4.24	14.79

ed of five parts wheat bran, one part ground oats, five parts corn meal and one part wheat middlings. The grain represented 41.9 per cent. of the cost of the ration and supplied 27.2 per cent. of the total digestible nutrients. The forage represented 36.4 per cent. of the cost of the ration and supplied 54.5 per cent. of the total digestible nutrients. From July 1st to 31st oat-and-pea forage was fed morning and noon, and hay at night; the same mixed grain morning and night as before. The grain represented 41.6 per cent. of the total cost of the ration and supplied 20.8 per cent. of the total digestible nutrients. The forage represented 36.8 per cent. of the total cost of the ration and supplied 64.8 per cent. of the total digestible nutrients. The ration for the second period had a little wider nutritive ratio than that for the first. There was an increase in the amount of each digestible constituent and an increase of the fuel value. The cost of the ration was somewhat less. There was a decrease in milk yield at about the normal rate—the percentage of fat was however slightly lower. There was a slight increase in the cost of milk and more in the

cost of fat. The average gain in weight per cow for June was 11.6 pounds and for July 2 pounds.

The greatest daily average milk yield for June was 31.9 pounds and the least 22.7 pounds. The highest average per cent. of fat was 4.69 and the lowest 3.20 per cent. For July the greatest daily average milk yield was 34.4 pounds and the least 16.4 pounds. The highest average per cent. of fat was 5.25 and the lowest 2.99 per cent. The following table shows the composition of each food used in this trial:

	Moisture. Per ct.	Ash. Per ct.	Protein Per cent.	Crude fibre. Per ct	N.-free extract. Per ct.	Fats. Per ct.	In water-free substance.	
							Total nitrogen. Per ct.	Albuminoid nitrogen. Per ct.
Alfalfa forage	75.3	2.0	3.7	6.6	11.3	1.1	2.41	1.90
Oat-and-Pea forage..	67.4	1.9	4.4	7.6	17.4	1.3	2.18	1.72
Clover hay (mixed)	12.0	4.9	8.5	28.9	43.4	2.3	1.55	1.38
Mixed grain No. 39.	10.6	3.3	11.6	5.7	64.7	4.1	2.08	1.89

Table XII. shows the results obtained in a feeding trial during July and August, 1894. Eight cows were used in this trial of the average age July 1st of 5.2 years. At that date they had been in milk on the average 3.7 months. From July 1st to 31st oat-and-pea forage was fed morning and noon, hay at night, and a mixed grain, No. 39, consisting of five parts wheat bran, one part ground oats, five parts corn meal, one part wheat middlings. The grain represented 41.7 per cent. of the cost of the ration and supplied 21.0 per cent. of the digestible nutrients. The forage represented 37.0 per cent. of the total cost of the ration and supplied 65.0 per cent. of the total digestible nutrients From Aug. 1st to Aug. 9th, inclusive, alfalfa forage was fed three times daily and mixed grain twice. The mixed grain, No. 40, was composed of four parts wheat bran, one part ground oats, eight parts corn meal, one part wheat middlings, and one part "King" gluten meal. The grain cost 45.2 per cent. of the cost of the ration—the forage representing 54.8 per cent. The grain supplied 21.6 per cent. of the total digestible nutrients, the forage supplying 78.4 per cent.

From Aug. 10th to 31st, inclusive, corn silage was fed three

times daily and mixed grain twice. The mixed grain, No. 41, was composed of six parts wheat bran, one part ground oats, two parts "King" gluten meal, and one part cotton seed meal. The grain represented 41.2 per cent. of the total cost of the ration and the silage 58.8 per cent. The grain supplied 25.9 per cent. of the total digestible nutrients and the silage 74.1 per cent. Although the grain was changed for the second period and alfalfa forage took the place of oat and-pea forage and hay—the food containing more moisture—there was almost no change in the proportion or amounts of the different constituents of the food. The nutritive ratio was the same and the fuel values nearly alike. The cost of the second ration was less. There was very little decrease in the milk yield, but a slight falling off in the percent. of fat. The cost of milk was about the same and the cost of fat somewhat higher.

In the third period when corn silage was fed instead of alfalfa forage, the cost of the ration was increased, and the nutritive ratio was made considerably wider. There was an increase in the amount of fat and a decrease in the protein; the total nutritive substance was less and the fuel value lower. There was a normal decrease in the milk yield and an increase in the per cent. of fat. There was considerable increase in the cost of milk and fat.

There was an average gain in weight during July of 14 pounds and an average loss during August of 17.3 pounds. For the first period the greatest daily average milk yield was 40.2 pounds, and the least 16.4 pounds. The highest average per cent. of fat was 5.25 and the lowest 2.92 per cent. For the second period the extremes in daily average milk yield were 37.1 pounds and 17 pounds and in average percentage of fat 5.50 and 2.55 per cent. For the third period the extremes in milk yield were 37.2 pounds and 12.4 pounds and in average percentage of fat 5.55 and 2.57 per cent.

TABLE XII—A.

Period.	Avg. live wt. per cow during period Lbs.	Average per day per cow.							
		Water. Lbs.	Corn silage. Lbs	Alfalfa forage Lbs.	Oat- and-pea forage Lbs.	Mixed hay. Lbs.	Mixed grain No. 39. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
July 1 to 31...	993.5	89.48	—-	——	51.85	5.94	5.96	63.75	27.46
Aug. 1 to 9....	991.6	99.69	——,	71.52	——	——	No. 40. 5.85	77.37	28.34
Aug. 10 to 31.	983.2	59.45	59.79	——	——	——	No. 41. 5.89	65.68	22.39

B.

Period.	Average per day per cow.								
	Moist- ure in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digest- ible nu- trients. Lbs.	Ratio of total protein to total carbo- hyd'tes in food (fats x 2¼).
July 1 to 31...	36.29	1.48	3.47	1.05	6.00	15.56	25.98	18.57	1:6.9
Aug. 1 to 9....	49.03	1.71	3.48	.99	7.31	14.85	26.63	18.64	1:7.0
Aug. 10 to 31.	43.29	1.12	2.46	1.58	3.43	13.82	21.27	14.50	1:8.5

C.

Period.	Nutri- tive ratio.	Per 1000 pounds live weight fed.						
		Digest- ible protein Lbs.	Digest- ible fibre. Lbs.	Digest ible N -free extract Lbs.	Digest- ible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
July 1 to 31...	1:7.1	2.45	4.26	11.25	.73	18.69	26.15	36486
Aug. 1 to 9....	1:7.1	2.43	3.87	11.80	.70	18.80	26.86	36620
Aug. 10 to 31.	1:9.2	1.61	2.20	9.63	1.31	14.75	21.63	30527

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per cent. casein and albumen in milk	Per cent. sugar in milk	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
July 1 to 31...	.61	3.68	3.54	5.17	.17	1.02	.98	1.43	3.60
Aug. 1 to 9 ...	.63	3.44	3.68	5.02	.17	.93	1.00	1.36	3.46
Aug. 10 to 31.	.61	3.81	3.65	5.12	.16	.98	.94	1.32	3 40

E.

Period.	Total cost of food average per day per cow. Cents.	Milk yield average per day per cow.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk solids. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk Cents.	Cost of food for one pound of milk solids. Cents.	Cost of food for one pound of fat in milk Cents.
July 1 to 31...	14.01	27.59	1.00	7.63	26.92	.51	3.89	13.74
Aug. 1 to 9....	13.04	27.07	1.05	8.19	30.47	.48	3.77	14.02
Aug. 10 to 31..	15.24	25.78	.87	6.59	22.85	.59	4.48	15.55

The composition of the oat-and-pea forage, of the hay and of the grain will be found on p 564, and the composition of each of the other foods will be found in the following table.

	Moisture. Per cent.	Ash. Per cent.	Protein Per cent.	Crude fibre. Per cent.	N-free extract. Per cent.	Fats. Per cent.	In water-free substance	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Alfalfa.....	67.7	2.2	3.9	9.9	15.3	1.0	1.95	1.73
Corn silage	71.5	1.4	2.1	5.1	18 0	1.9	1.19	.74
Mixed grain No. 40...	10.5	2.4	11.8	3.9	66.8	4.6	2.10	1.94
Mixed grain No. 41...	9.2	4.7	20.3	6.5	51.9	7.4	3.57	3.34

In table XIII are given the data obtained in a feeding trial from Sept. 1st to Oct. 15th, 1894. Seven cows were used which had been in milk on the average 4.1 months. The average age Sept.

1st was 5.6 years. There was a change to corn forage from alfalfa and oat-and-pea forage and with the results from the two periods those obtained in a third, when only hay and grain were fed, are given for comparison. From Sep. 1st to 15th, inclusive, alfalfa forage was fed in the morning, oat-and-pea forage at noon and night, and a mixed grain No. 40 composed of four parts wheat bran, one part ground oats, eight parts corn meal, one part wheat middlings and one part "King" gluten meal. The grain represented 45.8 per cent. of the cost of the ration, the forage representing 54.2 per cent. The grain supplied 22.9 per cent. of the total digestible nutrients, the forage supplying 77.1 per cent. From Sept. 16th to 30th, inclusive, corn forage was fed three times daily. The mixed grain fed, No. 42 was composed of five parts wheat bran, one part linseed meal, O. P., one part "King" gluten meal and one part cotton-seed meal. The grain represented 47.3 per

TABLE XIII—A.

Period.	Average live-weight per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Alfalfa forage. Lbs.	Oat-and-pea forage. Lbs.	Mixed hay. Lbs.	Mixed grain No. 40. Lbs.	Total food. Lbs.	Total dry matter in food. Lbs.
Sept. 1 to 15	963.9	74.00	22.25	43.84	——	5.67	71.76	24.96
Sept. 16 to 30.	975.5	51.10	——	Corn forage. 70.31	——	No. 42. 5.86	76.17	24.83
Oct. 1 to 15....	978.3	81.87	——	——	19.29	6.40	25.69	22.74

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-Free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible nutrients. Lbs.	Ratio of total protein to total carbohyd'tes in food. (Fats x 2¼.)
Sept. 1 to 15..	46.80	2.12	3 89	1.01	5.00	12.94	22.84	16.92	1:5.2
Sept. 16 to 30.	51.34	1.35	3.17	.99	3.69	15.62	23.48	17.51	1:6.8
Oct. 1 to 15...	2.95	1.12	2.37	.80	6.13	12.33	21.62	12.67	1:8.6

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed.						
		Digestible pr'tein. Lbs.	Digestible fibre. Lbs.	Digestible N-free extr'ct. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Sept. 1 to 15..	1:5.3	2.93	3.65	10.24	.74	17.56	23.70	34408
Sept. 16 to 30.	1:6.5	2.53	2.94	11.73	.75	17.95	24.07	35157
Oct. 1 to 15...	1:7.2	1.67	3.01	7.71	.57	12.96	22.09	25451

D.

Period.	Per cent. of ash in milk.	Per cent. of fat in milk.	Per cent. of casein and albumen in milk.	Per cent. of sugar in milk.	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk. Lbs.	Total solids in milk. Lbs.
Sept. 1 to 15..	.62	3.60	3.65	5.18	.16	.96	.97	1.38	3.47
Sept. 16 to 30	.64	3.79	3.76	5.12	.17	.99	.99	1.34	3.49
Oct. 1 to 15...	.62	3.94	3.77	5.18	.13	.81	.78	1.07	2.79

E.

Period.	Total cost of food aver'ge per day per cow. Cents.	Milk yield aver ge per day per cow. Lbs.	Pounds of water-free food consumed for one pound of milk produced. Lbs.	Pounds of water-free food consumed for one pound of milk-solids produced. Lbs.	Pounds of water-free food consumed for one pound of fat produced. Lbs.	Cost of food for one pound of milk. Cents.	Cost of food for one pound of milk-solids. Cents.	Cost of food for one pound of fat in milk. Cents.
Sept. 1 to 15..	12.25	26.56	.94	7.19	26.00	.46	3.53	12.76
Sept. 16 to 30	13.34	26.22	.95	7.11	25.08	.51	3.82	13.47
Oct. 1 to 15...	16.53	20.66	1.10	8.15	28.07	.80	5.92	20.41

cent. of the cost of the ration, the forage representing 52.7 per cent.; and the grain supplied 20 9 per cent. of the total digestible nutrients, the forage supplying 79.1 per cent. From Oct. 1st to 15th timothy hay was fed three times daily and the same mixed grain fed as during the preceding period. The grain represented

41.6 per cent. of the cost of the ration and supplied 31.5 per cent. of the total digestible nutrients.

In changing to the corn forage of the second period the nutritive ratio of the ration was made a little wider. There was somewhat less protein in the ration but almost the same amount of fat and of total nutrients, and there was not much difference in the fuel value;—the cost of the ration was a little higher. There was but very little falling off in the milk yield and the per cent. of fat in the milk was slightly higher. The cost of milk was somewhat higher and also the cost of fat. In the third period, although more grain was fed, not enough hay was taken to prevnt a falling off in the total dry matter consumed, Besides a decrease in the amount of protein—enough to make the ratio wider—there was a decrease in the amount of other constituents, and the fuel value of the ration was less. The cost of the ration was much higher. There was considerable falling off in milk yield and only an ordinary change in the composition of the milk. There was an average gain in weight during each of the first two periods of nearly twelve pounds and a loss of about six pounds during the last period.

The greatest daily average milk yield for the first period was 37.5 pounds and the least 19.7 pounds. The highest average per cent. of fat was 5.35 and the lowest 2.30 per cent. The extremes for the second period in milk yield were 38.0 pounds and 19.4 pounds and in average percentage of fat 5.50 and 2.60 per cent. For the third period the extremes were 30.1 pounds and 15.0 pounds, and 5.90 per cent. and 2.25 per cent.

The composition of the mixed grain, No. 40 will be found on page 567, and that of each of the other foods is given in the following table.

	Moisture. Per cent.	Ash. Per cent.	Protein. Per cent.	Crude fibre. Per cent.	Nitrogen-free extract. Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Alfalfa forage	72.1	2.4	5.2	7.9	11.2	1.2	2.98	2.02
Oat and pea forage...	68.8	3.3	4.7	6.9	15.2	1.1	2.39	1.88
Corn forage	72.1	1.5	2.5	4.7	18.3	.9	1.45	1.11
Mixed Timothy hay	11.6	4.1	4.3	29.6	48 3	2.1	.76	.69
Mixed grain No. 42	11 1	5.1	24.1	6.6	47.0	6.1	4.34	4.00

The results obtained in another trial with the same cows from Oct. 1st to Nov. 15th, 1894, are given in table XIV. The cows had been in milk on the average a little over five months by Oct. 1st. The data for the first period of this trial have just been reported in the preceding large table but are here repeated for comparison. In the second period alfalfa forage was fed in place of hay, and in the third period beets were fed. From Oct. 16th to 31st, inclusive, alfalfa forage was fed morning and noon and hay at night. The mixed grain, No. 43, consisted of five parts wheat bran, six parts corn meal, and one part each of wheat middlings, linseed meal, O. P., cotton seed meal and gluten feed. The grain represented 44.6 per cent. of the total cost of the ration and supplied 30.6 per cent. of the total digestible nutrients. The forage represented 32.0 per cent. of the cost of the ration and supplied 47.9 per cent. of the nutrients. From Nov. 1st to 15th, inclusive, beets were fed morning and noon and hay at night. The mixed grain, No. 44, consisted of five parts wheat bran, one part ground oats, two parts corn meal, one part linseed meal, O. P., two parts "King" gluten meal, and one part cotton seed meal. The grain represented 40.1 per cent. of the cost of the ration and supplied 33.1 per cent. of the total digestible nutrients. The beets represented 39.5 per. cent. of the cost of the ration and supplied 43.6 per cent. of the total digestible nutrients.

The nutritive ratio of the second ration was considerably narrower than that of the first. There was an increase in the amount of protein and fat, and of total nutrients. The fuel value was higher and the cost of the ration considerably less. There was a pronounced increase in the milk yield and not much change in the composition of the milk. The cost was much less for milk and fat than for the preceding period. In the third period the nutritive ratio was made wider, there was a decrease in the amount of digestible protein, fat, and of total nutrients—most noticeable in the fat. The cost of the ration was much higher and the fuel value was reduced to about that of the ration for the first period. There was a falling off in the milk yield from that of the second period, but very little more than the normal, accompanied by a slight decrease in the per cent. of fat. The milk and fat cost much more than in the second period.

There was an average loss in weight during October of about

TABLE XIV—A.

Period.	Avg. live wt. per cow during period. Lbs.	Average per day per cow. Water. Lbs.	Beets. Lbs.	Alfalfa forage Lbs.	Mixed hay. Lbs.	Mixed grain. No. 42. Lbs.	Total food Lbs.	Total dry matter in food. Lbs.
Oct. 1 to 15...	978.3	81.87	——	——	19.29	6.40	25.69	22.74
Oct. 16 to 31..	972.1	61.61	——	46.62	6.80	No. 43. 6.40	59.82	22.68
Nov. 1 to 15..	968.0	41.18	45.59	——	7.09	No. 44. 6.40	59.08	18.40

B.

Period.	Average per day per cow. Moisture in food. Lbs.	Ash in food. Lbs.	Protein in food. Lbs.	Fats in food. Lbs.	Crude fibre in food. Lbs.	N.-free extract in food. Lbs.	Total organic matter in ration. Lbs.	Total digestible Nutrients. Lbs.	Ratio of total protein to total carbohydrates in food. (Fats x 2¼.)
Oct. 1 to 15...	2.95	1.12	2.37	.80	6.13	12.33	21.62	12.67	1:8.6
Oct. 16 to 31..	37.14	1.55	3.93	1.02	4.54	11.63	21.13	14.19	1:4.7
Nov. 1 to 15...	40.68	1.27	2.51	.61	2.68	11.32	17.13	12.78	1:6.1

C.

Period.	Nutritive ratio.	Per 1000 pounds live weight fed. Digestible protein Lbs.	Digestible fibre. Lbs.	Digestible N.-free extract. Lbs.	Digestible fat. Lbs.	Total digestible nutrients. Lbs.	Total organic matter in ration. Lbs.	Calories of energy in ration. Cal.
Oct. 1 to 15...	1:7.2	1.67	3.01	7.71	.57	12.96	22.09	25451
Oct. 16 to 31..	1:4.6	2.79	2.32	8.74	.74	14.59	21.74	28884
Nov. 1 to 15..	1:6.1	1.94	1.45	9.33	.49	13.20	17.70	25727

D.

Period.	Per cent. ash in milk.	Per cent. fat in milk.	Per ct. casein and albumen in milk	Per cent. sugar in milk	Average per day per cow.				
					Ash in milk. Lbs.	Fat in milk. Lbs.	Casein and albumen in milk. Lbs.	Sugar in milk Lbs.	Total solids in milk Lbs.
Oct. 1 to 15...	.62	3.94	3.77	5.18	.13	.81	.78	1.07	2.79
Oct. 16 to 31..	.63	3.91	3.90	4.95	.15	.90	.89	1.13	3.07
Nov. 1 to 15 ..	.65	3.81	3.97	5.23	.14	.82	.85	1.13	2.94

E.

Period.	Total cost of food. Avg per day per cow. Cents.	Milk yield. Avg per day per cow. Lbs.	Pounds of water-free food consumed for one lb of milk produced. Lbs.	Pounds of water-free food consumed for one lb. of milk solids produced. Lbs.	Pounds of water-free food consumed for one lb. of fat produced. Lbs.	Cost of food for one lb. of milk Cents.	Cost of food for one lb. of milk solids. Cents.	Cost of food for one lb. of fat in milk Cents.
Oct. 1 to 15...	16.53	20.66	1.10	8.15	28.07	.80	5.92	20.41
Oct. 16 to 31..	14.56	22.91	.99	7.39	25.20	.64	4.74	16.18
Nov. 1 to 15 ..	17.33	21.53	.85	6.29	22.44	.80	5.89	21.13

12 pounds and during the third period of about 2 pounds. The greatest daily average milk yield for the second period was 32.6 pounds and the least 17.1 pounds. The highest average per cent. of fat was 5.60 and the lowest 2.70 per cent. For the last period the extremes in daily average milk yield were 30.9 pounds and 15.6 pounds, and in per centage of fat 6.00 and 2.60 per cent. The composition of the hay and of the mixed grain, No. 42, fed during the first period, will be found on page 570. The following table shows the composition of each of the other foods.

	Moisture. Per cent.	Ash. Per cent.	Protein Per cent.	Crude fibre. Per cent.	Nitrogen-free extract. Per cent.	Fats. Per cent.	In water-free substance.	
							Total nitrogen. Per cent.	Albuminoid nitrogen. Per cent.
Alfalfa forage	76.5	2.3	5.5	4.8	9.7	1.2	3.73	2.94
Beets	85.4	1.5	1.4	.8	10.8	.1	1.49	.75
Hay (Nov. 1 to 15) ..	14.4	4.9	7.2	28.8	42.6	2.1	1.35	1.24
Mixed grain No. 43	10.8	3.2	16.9	4.2	59.9	5.0	3.02	2.94
Mixed grain No. 44	11.4	3.7	21.3	4.4	52.8	6.4	3.84	3.63

GENERAL OBSERVATIONS.

These feeding trials here reported, though many of them for periods necessarily rather short, were repeated for several seasons and are the average results from a number of different cows, so that the indications which they all give of the value of alfalfa can hardly be considered accidental.

The average of all the analyses made of the fourteen lots of alfalfa used in these feeding trials will give an idea of the general composition of alfalfa forage. The average composition of three lots of mature corn forage might be considered beside that of the alfalfa for comparison as follows:

	ALFALFA FORAGE.	CORN FORAGE.
Per Cent. of Moisture, ...	75.10	71.80
" " Ash, ...	2.28	1.20
" " Protein, ...	4.48	2.27
" " True albuminoids, ...	3.53	1.97
" " Crude fibre, ...	6.59	5.17
" " N.-free extract	10.26	18.46
" " Fats, ...	1.29	1.10

In determining the cost of milk, for purpose of comparison, for each period reported in the preceding tables, the cost of the food only was considered. The manurial values of the foods were not taken into account, although under favorable conditions the net cost to the farm of milk would be much influenced by the fertilizing values of the foods. The manurial values of rations containing alfalfa and of those containing highly nitrogenous grain foods would be much greater than of most rations, but except where especial attention is given to careful handling of manure, only a small proportion of the possible amount would be recovered.

When alfalfa forage was substituted for some other food or the amount of alfalfa in the ration increased, there followed in ten instances a decrease in the cost of the milk, in two instances a very slight increase in cost, and in two instances the cost of milk was practically the same. There was an increase in the yield of milk in seven instances, a decrease in four instances of about what might normally be expected to occur without change of food, and little change in yield in three instances.

When the change was from a ration containing alfalfa to one containing less or no alfalfa, there followed an increase in the cost of milk in ten instances and there was about the same cost once. There was a decrease of the milk yield in nine instances, and an increase of the milk yield in two.

When alfalfa was substituted for other foods in the ration or the amount of alfalfa increased there followed a decrease in the cost of fat in seven instances and an increase of the cost in six instances. There was an increase of the amount of fat in six instances, a decrease in five instances, and little change in amount twice.

When the change was from a ration containing alfalfa to one containing less or none, there followed an increase in the cost of fat in nine instances, a decrease in cost once, and there was about the same cost twice. There was an increase of the amount of fat in three instances, a decrease in three, and about the same amount of fat in five.

When the change in the ration was to more alfalfa, or to alfalfa in place of some other food, there followed a decrease in per cent. of fat in milk in six instances, an increase in three, and little change in per cent. in four instances. When changed from a ration containing alfalfa to one containing less or none, there followed an increase in per cent. of fat in six instances and a decrease of per cent. in five.

There has been usually an increase in milk yield accompanying the use of alfalfa although there was often at the same time a decrease in the per cent. of fat. With alfalfa forage rated at the same cost as other forage there was generally a decrease in the cost of milk when the alfalfa was fed, and not much change in the cost of the fat produced.

Corn forage (fully matured) in the results accompanying its'

use has compared most favorably with alfalfa ; but except in the form of silage it is only available for a short time in the fall before frost. Alfalfa is ready for the first cutting about the time for planting the corn and about as early as rye forage can be cut. The proportions of constituents also differ so widely between alfalfa and corn forage that these plants cannot well be considered as substitutes for each other but as supplementary. For making rations like those usually fed, coarse fodder and grain foods, in general cheaper than those used with corn forage, can be fed with alfalfa. The more highly nitrogenous grains and hays fed with corn forage or silage, however, have a much higher manurial value, which fact is often of wide importance.

The palatability of alfalfa or of corn (maize) is greater than of most other forage plants of rapid growth that will yield heavy crops. This is a matter of the greatest importance, for while the milk may temporarily be produced at the expense of loss in weight of the animal, the flow of milk must be sustained by the food taken in excess of that necessary for maintenance.

Any discussion of the general fluctuations of milk yield as influenced by the proportions of the different constituents of the food, and by the nutritive ratio of the ration, is reserved until some data from winter rations fed for longer periods shall be published.

REMARKS CONCERNING THE CULTIVATION OF ALFALFA.

For those who are unacquainted with alfalfa a few general facts concerning the plant may be briefly mentioned here to advantage. Alfalfa (Medicago sativa),sometimes called lucerne,although not generally grown in this part of the country has been in cultivation for a long time. It was cultivated by the Egyptians, Greeks and Romans, and in later centuries by the nations of the warmer parts of Europe. It was early introduced into South America and brought from there to Mexico and California.

Alfalfa being a leguminous plant like the clovers and able to gather nitrogen that is not available to most plants, will, when the crop is fed on the farm, enrich the soil in this necessary element, and leave a field in improved condition when finally plowed

under. The long tap root with its numerous branches reaches deep in the sub-soil (roots often reach to a depth of ten or twelve feet—are said sometimes to extend over twenty feet) and is often able to obtain plant food and water for the lack of which surface feeding plants may be suffering. The plant is a perennial and when once well established will yield paying crops for an indefinite number of years if the field is not overrun with grass or plantain.

Alfalfa grows well on widely varying kinds of top soil, but the sub-soil must be open and porous. It does best on a warm and friable soil with a loose or gravelly sub-soil. A dense clay or hardpan subsoil is most unfavorable. Although a rich soil is of course the best and gives the largest crops, alfalfa sometimes does exceedingly well on poor gravelly soils. The plant consumes much water but will not survive long in a saturated or flooded soil, and too much water in the soil during winter is fatal. If water stands for any considerable time within a few feet of the surface the crop will be injured. Alfalfa, in the West, seldom if ever winter kills on ground with a deep and porous sub-soil.

The seed should not be sown except the soil has received careful and thorough preparation, for it is of the utmost importance to secure a dense and uniform stand, especially if hay is to be made. If crops of seed only are desired a more scattering stand of plants may give good results. The seed should be sown in the spring, after danger of severe frost is past, and when the ground would be considered in the best possible condition for planting garden seeds. The treatment of the soil for the preceding season should have been such as to have most effectually subdued all weeds, and caused the sprouting and destruction of any seeds in the ground. The seed should not be sown with grain, but alone; although a good catch is sometimes reported when sown with oats—only about half the usual quantity of grain being used. If sown with grain the young plants are likely to be killed by the sun after the grain is cut. It is best to sow not less than thirty pounds of seed per acre—especially when sown broadcast. When sown with the drill twenty pounds often give good results. In short, to guard against the decidedly unsatisfactory result of a poor stand, plenty of seed should be used on carefully prepared ground.

Pure seed is essential. Only plump, bright, good seed should be sown, for shrunken seed may produce weak and worthless plants. The seed resembles that of red clover but is larger. Too many small seeds would indicate the possible admixture of white clover, etc. The presence of the seed of narrow-leaf-plantain or rib-grass it is of vital importance to guard against. This is a long brownish seed something like a diminutive date seed and is easily detected without the aid of a glass by anyone familiar with it.

In order to check the growth of weeds a mowing machine can be run over the field of young alfalfa with the cutting bar raised so as to avoid cutting near the crowns of the young plants. If the clipping is not too heavy it can, with advantage, be left on the field, and will serve as a mulch during the dry weather. On rich soil sometimes two crops can be secured the first year, but on poor soil or in a dry season no crop can be expected the first year. Alfalfa should be cut every time it begins to blossom whether the growth is short or tall, unless a seed crop is desired. The second crop of the season is better for seed than the first, possibly on account of the greater number of insects that assist in fertilizing the blossoms.

Alfalfa is of exceptional value as a soiling crop, but it will also make excellent hay, palatable and very nutritious. Much care and time are necessary to make good hay and experience and good judgment are required. If handled much when very dry all the leaves are likely to fall off, and if not thoroughly cured it is likely to mold and mildew. The hay will not shed water well and any stacks should be well covered.

If you have a suitable field, try a small patch of alfalfa,—not too much at first.