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Pea Meal as a Feed for Dairy Cows

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SUMMARY AND CONCLUSIONS

During the last six years an average of about 67 million pounds of seed peas have been grown annually in Idaho. Assuming 15 per cent dockage and by-products, about 10 million pounds or 5,000 tons of material would be available annually that might be used for livestock feed.

Straight pea meal, made by grinding recleaned waste peas, is a rather high protein feed, containing about 22 to 25 per cent crude protein. The percentage of protein in the various pea products varies with the proportion of pea hulls or cereal grains and weed seeds ground with the waste peas.

The various by-products are described and the chemical composition of samples is reported. Percentage of hull and pulp samples of four varieties of dry peas is reported. Comparison is made of the four varieties with respect to chemical composition of the whole pea, pulp, and hull.

Pea meal was compared with linseed meal in two feeding trials in which 18 cows were used. Alfalfa hay and sunflower silage were fed throughout the trials. A grain mixture of 400 pounds of barley, 200 pounds of wheat bran, 100 pounds of linseed meal, and 21 pounds of mineral mixture was compared with a mixture of 400 pounds of barley, 200 pounds of bran, 200 pounds of pea meal, and 21 pounds of mineral mixture.

The two grain mixtures were quite similar in digestible crude protein and total digestible nutrient content. The results indicate that pea meal may be used to good advantage as a feed for dairy cows.

When 200 pounds of pea meal were substituted for 100 pounds of linseed meal as a protein supplement to 400 pounds of barley and 200 pounds of wheat bran, the results were at least equal to those obtained when the linseed meal was used. On a thousand-pound basis, 250 pounds of pea meal replaced 143 pounds of linseed meal, 71 pounds of barley, and 36 pounds of bran.

Results of two palatability trials, 16 cows each, indicate that although pea meal may not be relished by dairy cows as much as some common cereals, palatability would not be a limiting factor when grain mixtures containing up to 75 per cent pea meal are fed.

Pea Meal as a Feed for Dairy Cows

By

F. W. ATKESON, T. R. WARREN AND D. W. BOLIN*

THE Palouse area of northern Idaho and eastern Washington is the largest commercial and seed pea section in the United States. (4) During the six-year period, 1929-1934, the seed pea crop in Idaho averaged 1,111,000 bushels, or about 67 million pounds. Most of this seed is grown in two regions of the state —the Palouse area around Moscow, and the Upper Snake River region around Idaho Falls. The peas are threshed dry and either are sold for seed in areas of the United States where canning peas are grown or are used as split peas for soup.

Dockage products consisting of weevil-damaged peas, shriveled or cracked peas, grain and weed seeds, and other foreign matter, represent from 10 to 20 per cent of the total crop. (5) In addition, by-products are available such as pea hulls or bran, pea germs, pea chips, consisting of pieces the size of wheat or smaller, and pea flour or dust.

Assuming that 15 per cent of the 67 million pounds were dockage or by-products, there would be available about 10 million pounds, or 5,000 tons of this material. The quantity available annually justifies further investigation of the value of these products as a feed for livestock.

Knott, Tretsven, and Hodgson (5) found in feeding trials at the Washington Agricultural Experiment Station that 500 pounds of pea feed could be substituted in the grain mixture for 400 pounds of wheat bran and 100 pounds of linseed meal with equally good results. They report the pea feed used was a mixture of damaged peas and pea hulls, the proportion of each being approximately 50 per cent by weight. This is a much larger percentage of hulls than was contained in the pea meal used in the feeding trials herein reported. The average digestion coefficient which they reported for pea feed, using three dairy heifers as experimental animals, was as follows: dry matter 87.86 per cent, crude protein 81.85, crude fiber 86.86, nitrogen-free-extract 93.2 and ether extract 68.30.

DESCRIPTION AND COMPOSITION OF PEAS AND PEA PRODUCTS

Pea processing plants have various by-products resulting from the cleaning and splitting operations. The weevil-damaged peas

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and light peas are called "tailings" and when ground are labeled "pea meal." Screenings are a mixture of broken pieces of peas together with grain seeds, weed seeds, etc., screened out in the cleaning process. These hulls, together with small quantities of fine chips are known as "pea bran." Also, in the splitting process the germs are separated off together with small chips broken in the splitting. These two products are often labeled "pea germs" or "fine chips." "Pea flour," or "dust," is obtained when the splits are polished to give them luster. In an attempt to market a surplus of the less valuable products or in making a feed for special demand, the processors sometimes mix some of the by-products together in various proportions or blends.

The greatest differences in the composition of the various products are found in the protein and fiber contents. In general, the greater the percentage of hulls present, the lower is the protein content and the higher the fiber. Table I shows some analyses of by-products of pea-processing plants.

In order to obtain information on the relative percentage of the peas that are hulls, four common varieties of peas grown in the Palouse area were sampled, hulled by hand, and the fractions weighed. Of the four varieties studied (Table II) Bluebell and White Canada had the smallest proportion of hull, 7.7 and 7.8 per cent respectively. Alaska ranked next with 9.2 per cent. The largest percentage of hulls, 12.5, was found in the Kaiser. If these differences consistently prevailed in additional samples, the feeding value of pea meal might vary to some slight extent with the different varieties.

Table III shows the chemical composition of the whole peas, the hulls, and the pulp of the four varieties previously discussed. Data are presented on both the air-dry and oven-dry basis as differences in moisture make direct comparisons of the other constituents difficult. Attention should be directed to the fact that the percentage of moisture may be lower than representative samples of peas, because the samples were kept in the laboratory considerable time, waiting for data in Table II to be obtained before analyses were made. Lower moisture content also would affect slightly the percentage of other constituents.

In the samples analyzed the calcium (CaO) averaged 0.28 per cent in the whole peas, 0.22 per cent in the pulp, and 1.38 per cent in the hulls. Compared with reported analyses (3) on other concentrate feeds the whole peas and the pulp are very similar in calcium content to soybeans (0.29) and navy beans (0.28). The whole peas were about twice as high as cowpeas (0.14). Dried beet pulp, linseed meal, gluten feed, and cottonseed meal were the only concentrate feeds which were materially higher than peas in calcium. Pea hulls (hulled by hand) contained an average of 1.38 per cent of calcium, which is much higher than dried beet

pulp (0.92) and linseed meal (0.51), the two feeds highest in calcium of all the concentrates reported. (3) Although the concentrate feeds are not usually as good a source of calcium as are the leguminous roughages, the pea hulls contained almost as much calcium as clover hay (pea hulls, 1.38 per cent and clover hay, 1.60 per cent). Since the pea hulls contained almost 50 per cent fiber, while clover hay contains about 25 per cent, and wheat bran 16.6 per cent, the pea hulls might be considered more as a roughage than as a concentrate feed. It is well to stress the fact that these hulls were separated by hand, but the analyses of hulls reported in Table I show a composition remarkably similar to clover hay, even though that sample contained some chips and was taken directly from the processing plant, as previously discussed.

The phosphorus (P_2O_5) content of the whole peas averaged 1.07 per cent, the pulp 1.07 per cent, and the hulls 0.19 per cent. The low phosphorus content of the hulls might appear unusual when compared with wheat bran, which is nearly three times as high in phosphorus as wheat. Apparently the phosphorus is linked with the protein in both cases, as the wheat bran is much higher in protein than wheat, while just the reverse is true in the case of peas, the hulls containing only about one-fifth as much protein as the pulp. The average protein content of the four samples was as follows: whole peas, 22.2 per cent; pulp, 23.4 per cent; and hulls, 4.8 per cent.

Whole peas contained about the same phosphorus (1.07 per cent) as has been reported for cowpeas (1.01), about a third more than navy beans (0.78), and less than soybeans (1.37). Since wheat bran with 2.95 per cent phosphorus, cottonseed meal with 2.67, and linseed meal with 1.70, are the highest in this constituent of all the common feeds, and are especially prized, partially because of their phosphorus content, it would seem that ground peas with 1.07 per cent may be considered a valuable feed source of phosphorus.

DESCRIPTION OF PEA MEAL USED

The pea meal used in the experiments herein reported was made from the Alaska variety of peas. The sample used in Trial II contained shriveled, cracked, and small peas with a small amount of wild and tame oats. When grinding the peas additional pea hulls were added to represent 18.2 per cent of the total. After grinding, the pea meal weighed 44 pounds per bushel. During the first trial an attempt was made to select a fairly representative lot of pea meal from the Alaska variety. Chemical analyses showed that the pea meal used in Trial II was slightly higher in crude protein and lower in fiber, indicating the meal used in Trial I probably contained more hulls.

FEEDING TRIALS

Two feeding trials, 96 days in length, were conducted at the Idaho Agricultural Experiment Station at Moscow. Trial I began

December 22, 1929, and ended March 27, 1930, while Trial II covered the period from December 20, 1930, to March 27, 1931. The conditions under which the two trials were conducted were kept as uniform as possible. Each trial was divided into three 32-day periods. The first eight days were used as a preliminary, or transition, period and the following 24 days as the experimental period.

Two groups of cows were used in each trial. An effort was made to balance the groups as evenly as possible with respect to breed, age, body weight, days in lactation, days in gestation, and daily milk and butterfat production. Eight cows, 6 Holsteins and 2 Jerseys, were selected from the University pure-bred herd for Trial I, while 10 cows, 6 Holsteins and 4 Jerseys, were used in Trial II.

All the cows in both trials were fed alfalfa hay and sunflower silage throughout the experiment, the variant in the ration being the grain mixture. The grain mixture used as a basis for comparison consisted of 400 pounds of rolled barley, 200 pounds of wheat bran, 100 pounds of linseed meal, and 21 pounds of mineral mixture. The experimental grain mixture was just the same except that 200 pounds of pea meal were substituted for the 100 pounds of linseed meal. The linseed meal represented 1 part in 7, other than salt, or 14.3 per cent of the one mixture; while the pea meal represented 2 parts in 8, or 25 per cent of the other mixture. Therefore, on a thousand-pound basis, 250 pounds of pea meal replaced 143 pounds of linseed meal, 71 pounds of barley, and 36 pounds of bran.

Preliminary calculations indicated that these two grain mixtures would be fairly equal in digestible crude protein and total digestible nutrients. Chemical analyses (Table IV) seemed to justify this conclusion.

The crude protein of both mixtures was approximately 15 per cent.

The double reversal system of experimentation was used. Cows in Group I of each trial were fed the pea meal-grain mixture during the first and third periods and the linseed meal mixture during the second period. Simultaneously, cows in Group II were fed the linseed meal mixture during the first and third periods and pea meal mixture during the second period.

Before the experiment was begun data were obtained on the daily consumption of alfalfa hay and silage for each cow. From these records the quantity of each of these feeds to be fed daily to each cow was determined. An attempt was made to keep the daily consumption of hay and silage constant for each cow throughout all three periods of the feeding trial. The grain mixtures were fed to the Holstein cows at the rate of 1 pound of grain to 4 pounds of milk produced daily. Jerseys were fed at the rate of 1 to 3. Using these ratios the quantity of grain mixture fed was adjusted every

sixth day according to the average daily production of the previous six days.

The cows were fed 2 or 3 times daily, according to the number of times milked per day. They were fed in stalls equipped to prevent loss of feed. Alfalfa hay was fed long in Trial I, but in Trial II it was chopped to minimize waste. Locally grown first cutting hay of good quality was fed in both trials. The sunflowers were grown on the college farm and the silage was typical in quality for the area. The barley and bran used were representative of average quality. Old process linseed meal of good quality was used. The pea meal fed has been previously discussed.

All feed given to individual cows and all feed refused by each was weighed and sampled for chemical analysis. Composite samples of the linseed meal grain mixture and the pea meal mixture were analyzed for each trial. To facilitate comparison of linseed meal and pea meal, they were also analyzed individually. In determining the nutrients consumed the nutrients in feeds refused were deducted from those fed.

Except for very stormy days the cows were allowed to exercise in a dry lot from 6 to 8 hours daily. Water was supplied in individual drinking cups attached to the stalls. Each cow was weighed between 7 and 8 o'clock three successive mornings, at the beginning of the experiment, the last 3 days of each preliminary, or transition, period, and the last 3 days of each 24-day experimental period. The average of the three successive daily weights was considered the true weight. Each cow's daily milk production was recorded, and composite samples were taken for butterfat analysis during each 8 days of the 24-day experimental periods.

RESULTS

In Table V is presented a summary of the results of each group for both trials. The average of the first and third periods was compared with the second period in all instances to offset the natural decline in production as the experiment progressed.

The results obtained from the two rations were as identical as it would seem possible to obtain, even from two groups of cows on the same feeds. The fact that the average butterfat production per cow for each of the four groups was approximately 1 pound per day would indicate that the production was sufficiently high to reflect significant differences in the two rations.

In Trial I the average daily feed consumption of both groups of cows while being fed the linseed meal ration was 30.6 pounds of silage, 14.7 of hay, and 7.2 of grain mixture. While on the pea meal ration these same cows consumed daily 31.0 pounds of silage, 14.8 of hay, and 7.1 of grain mixture. Daily production of milk and butterfat of the eight cows while being fed the two rations averaged exactly the same, 26.6 pounds of milk and 0.95 of a

pound of butterfat. Daily production of 4 per cent milk (Fat-corrected basis) (2) was 24.9 pounds per cow when the linseed meal mixture was fed and 25.0 pounds when the pea meal mixture was fed. The purpose of presenting this calculation is to combine into one figure the total energy output in milk and butterfat. It is obtained by multiplying the pounds of milk by 0.4 and adding this result to the pounds of fat multiplied by 15.

The average weight of the cows when placed on each ration was practically the same, 1201 pounds when started on the linseed meal mixture and 1205 when started on the pea meal mixture. Changes in body weights showed an average gain of 6.3 and 11.6 pounds per cow on the respective rations. These changes are not significant as it has been shown that a variation as much as 14 pounds due to chance may be expected when animals are weighed three consecutive days under standard conditions (1).

Daily intake of digestible nutrients per cow was practically the same on the two rations, 2.73 pounds of digestible crude protein and 16.5 pounds of total digestible nutrients being consumed when the linseed meal mixture was fed, and 2.62 pounds of protein and 17.0 pounds of total digestible nutrients when the pea meal mixture was fed. The nutrients consumed for each 100 pounds of 4 per cent milk on the linseed and pea meal rations were 11.0 pounds of digestible crude protein and 66.3 pounds of total digestible nutrients, and 10.5 and 68.0 pounds, respectively.

Although the plane of production was slightly higher in Trial II, the results obtained from the two rations were again quite similar (Table V). When the 10 cows, representing two groups of 5 cows each, were averaged together the daily feed consumption per cow was 30.9 pounds of silage, 18.9 of hay, and 8.8 of grain mixture when fed the linseed meal ration, and 30.9 pounds of silage, 18.8 of hay, and 8.6 of grain mixture when fed the pea meal ration. Average daily production per cow was 29.2 pounds of milk and 1.10 pounds of butterfat when the linseed meal mixture was fed and 28.7 pounds of milk and 1.09 pounds of butterfat when the pea meal mixture was fed. Average daily production of 4 per cent milk ("fat-corrected basis") was 28.3 and 27.8 pounds on the linseed meal and pea meal mixtures, respectively.

Body weights of the cows averaged 1178 pounds per cow when starting on the linseed meal ration and 1184 pounds when starting on the pea meal ration. Respective losses of 5.7 and 3.1 pounds in 24 days while on the two rations are not significant changes in weight.

Daily intake of digestible nutrients per cow was quite similar on the two rations, 2.89 pounds of digestible crude protein and 18.8 pounds of total digestible nutrients being consumed when the linseed meal mixture was fed, and 2.75 pounds of digestible crude protein and 18.8 pounds of total digestible nutrients when the

pea meal mixture was fed. The nutrients consumed for each 100 pounds of 4 per cent milk was 10.3 pounds of digestible crude protein and 66.8 pounds of total digestible nutrients when linseed meal was fed, and 10.0 pounds of digestible crude protein and 68.1 pounds of total digestible nutrients when pea meal was fed.

The results obtained from the two rations during these two trials were as identical as it would seem feasible to obtain.

PALATABILITY

Many farmers near Moscow have fed straight pea meal to their dairy cows. In order to determine the palatibility of pea meal when cows were well fed according to good commercial practice, a trial was run with 16 cows during both years of the experiment. The trial feeds contained 50, 75, and 100 per cent pea meal, the feeds used other than pea meal being ground barley and wheat bran in the ratio of 2 to 1.

During the first trial eight cows were fed straight pea meal the first day, the 75 per cent pea meal mixture the second day, and the 50 per cent pea meal mixture the third day. Four of the cows ate the straight pea meal without hesitation and three others ate all the feed but more slowly and apparently with less relish. One cow refused to eat the pea meal except in the 50 per cent mixture. When fed the 75 and 50 per cent pea meal mixtures the other 7 cows readily ate all the grain given. The other group of 8 cows was started on the 50 per cent mixture the first day, changed to the 75 per cent the second day, and given straight pea meal the third day. All the cows readily ate the 50 and 75 per cent mixtures. Five of the cows relished the straight pea meal while the other three, although they consumed all of it, required more time than usual and ate with less relish.

In the trial conducted the second year 16 cows were fed similar grain mixtures, all of the cows being fed the 50 per cent mixture the first day, the 75 per cent mixture the second day, and straight pea meal during the third, fourth, and fifth days. One cow refused to eat any of the mixtures offered. Eleven of the cows readily ate all the feed offered, including the straight pea meal. The other four cows varied in their relish of pea meal mixtures.

The protein content of pea meal would indicate that other feeds should be mixed with it for best results. Also, the palatability tests conducted and the experiences of some farmers justify the conclusion that although straight pea meal is probably not as palatable as some ground cereal grains, nevertheless, palatability would not be a serious problem in most commercial dairy herds, even when pea meal makes up as much as 75 per cent of the grain mixture.

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TABLE I.

Chemical Analyses of Peas and Pea-By-Products

(In per cent)

	Moisture	Ash	Crude Protein	Crude Fat	Crude Fiber	Nitrogen Free Extract
Tailings (whole peas	11.9	3.0	25.3	3.4	5.8	50.6
shriveled and small)	0.0	3.4	28.7	3.9	6.6	57.4
Screenings (broken peas, grain seeds, weed seeds,	10.8	6.9	18.4	2.1	4.2	57.6
chaff, etc.)	0.0	7.8	23.3	2.4	4.7	61.8
Screenings	10.8	4.7	18.1	2.4	10.6	53.4
(same as above)	0.0	5.7	20.7	2.7	11.9	59.0
Pea meal	11.3	4.0	18.5	1.4	21.1	43.7
(some hulls)	0.0	4.5	20.4	1.6	22.8	50.7
Feed blend	11.2	3.8	18.1	2.7	17.1	47.1
(60% tailings 40% hulls)	0.0	4.3	20.4	3.0	19.1	53.2
Ground	10.3	3.4	12.1	1.4	29.0	43.8
hulls	0.0	3.8	13.5	1.5	32.8	48.4
Fine	9.0	3.1	29.6	1.7	2.3	54.3
chips	0.0	3.4	32.5	1.8	2.5	59.8
Pea flour and	9.9	3.4	28.4	2.0	3.0	53.3
fine chips	0.0	3.8	31.6	2.2	3.3	59.1
Pea flour	8.1	4.2	27.0	1.7	2.1	56.9
or dust	0.0	4.6	29.4	1.9	2.3	61.8
Pea germ and	7.5	6.5	32.0	2.9	2.2	48.9
fine chips	0.0	7.1	34.6	3.1	2.4	52.8

NOTE: Chemical analyses made by Department of Agricultural Chemistry, Idaho Agricultural Experiment Station.

TABLE II.

Percentage of Hull and Pulp in Four Varieties of Dry Peas.

Variety	Blue Bell	Alaska	White Canada	Kaiser
Per cent of hull or bran	7.7	9.2	7.8	12.5
Per cent of pulp	92.3	90.8	92.2	87.5
Total	100.0	100.0	100.0	100.0

TABLE III
Chemical Analyses of Four Varieties of Dry Peas
Whole Pea, Pulp, and Hull
(In per cent)

Description	Moisture	Crude Protein	Crude Fiber	Nitrogen Free Extract	Ether Extract	Ash	CaO	P_2O_5
Blue Bell Pea (Entire)	10.05	20.69	4.97	60.38	1.36	2.55	0.260	1.10
Alaska (Entire)	8.80	21.50	5.98	59.67	1.01	2.80	0.215	1.07
Kaiser (Entire)	8.20	23.10	6.57	58.49	1.02	2.62	0.400	0.97
White Canada (Entire)	8.60	23.50	5.45	58.08	1.48	2.89	0.266	1.15
Blue Bell (Entire)	0.0	23.00	5.53	67.13	1.51	2.83	0.289	1.22
Alaska (Entire)	0.0	23.65	6.58	65.60	1.11	3.08	0.237	1.18
Kaiser (Entire)	0.0	25.16	7.16	63.71	1.11	2.85	0.436	1.06
White Canada (Entire)	0.0	25.71	5.96	63.54	1.62	3.16	0.297	1.26
Blue Bell Pulp	9.37	21.52	1.77	63.63	1.12	2.59	0.160	1.01
Alaska Pulp	8.76	22.44	1.64	63.30	1.03	2.84	0.173	1.07
Kaiser Pulp	8.48	26.07	1.51	60.50	0.94	2.50	0.370	1.03
White Canada Pulp	8.55	23.51	1.54	62.29	1.10	3.01	0.170	1.17
Blue Bell Pulp	0.0	23.74	1.95	70.21	1.24	2.86	0.177	1.11
Alaska Pulp	0.0	24.60	1.79	69.38	1.12	3.12	0.190	1.17
Kaiser Pulp	0.0	28.49	1.65	66.11	1.03	2.73	0.404	1.13
White Canada Pulp	0.0	25.71	1.68	68.11	1.20	3.29	0.186	1.28
Blue Bell Hulls	8.45	3.94	51.21	32.72	0.45	3.23	1.28	0.187
Alaska Hulls	8.11	5.28	49.74	32.43	0.50	3.96	1.390	~~1.86~~ .166
Kaiser Hulls	9.00	5.47	41.89	40.27	0.52	2.85	1.50	0.220
White Canada Hulls	8.47	4.37	51.09	31.90	0.25	3.92	1.33	0.173
Blue Bell Hulls	0.0	4.30	55.94	35.74	0.49	3.53	1.40	0.204
Alaska Hulls	0.0	5.74	54.12	35.29	0.54	4.31	1.510	~~1.81~~ .181
Kaiser Hulls	0.0	6.01	46.03	44.25	0.57	3.13	1.65	0.242
White Canada Hulls	0.0	4.77	55.82	34.85	0.27	4.28	1.45	0.189

NOTE: Chemical analyses made by Department of Agricultural Chemistry, Idaho Agricultural Experiment Station.

TABLE IV.
Chemical Analyses of Feeds.
(In per cent)

Feed	Water	Ash	Crude Protein	Crude Fiber	Nitrogen Free Extract	Fat
Trial I.						
Pea Meal Grain Mixture	8.3	4.2	13.9	13.2	57.1	3.3
Linseed Meal Grain Mixture	9.1	4.5	15.4	8.8	58.4	3.8
Silage* (Sunflower)	78.1	2.2	2.0	6.4	10.2	1.1
Alfalfa** (as consumed)	10.2	5.7	14.5	28.4	39.2	2.0
Trial II.						
Pea Meal Grain Mixture	7.8	4.2	14.9	7.8	63.1	2.2
Linseed Meal Grain Mixture	8.5	4.7	15.5	6.8	62.4	2.1
Silage (Sunflower)	76.4	2.6	2.3	6.4	11.3	1.0
Alfalfa** (as consumed)	14.7	7.5	11.5	27.0	37.3	2.0

* Taken from "Feeds and Feeding" by Henry and Morrison, 1923.
** Calculated by deducting nutrients in hay refused from nutrients in hay fed.
NOTE: Chemical analyses made by Department of Agricultural Chemistry, Idaho Agricultural Experiment Station.

TABLE V

Results of Two Feeding Trials Comparing Pea Meal with Linseed Meal for Dairy Cows.

	Trial I						Trial II					
	Group I		Group II		Average of both groups		Group I		Group II		Average of both groups	
	Lin. meal ration	Pea meal ration	Lin. meal ration	Pea meal ration	Lin. meal ration	Pea meal ration	Lin. meal ration	Pea meal ration	Lin. meal ration	Pea meal ration	Lin. meal ration	Pea meal ration
Period	II	I & III ave.	I & III ave.	II			II	I & III ave.	I & III ave.	II		
Number of cows used*	4	4	4	4	8	8	5	5	5	5	10	10
Ave. lbs. of sunflower silage consumed daily per cow	29.3	32.0	32.0	30.0	30.6	31.0	31.7	32.2	30.2	29.6	30.9	30.9
Ave. lbs. of hay consumed daily per cow	14.6	14.1	14.9	15.6	14.7	14.8	18.0	18.1	19.7	19.4	18.9	18.8
Ave. lbs. of grain mixture consumed daily per cow	7.1	6.8	7.3	7.3	7.2	7.1	9.5	9.5	8.1	7.6	8.8	8.6
Ave. lbs. of milk produced daily per cow	26.0	25.7	27.2	27.5	26.6	26.6	32.4	32.1	25.9	25.3	29.2	28.7
Ave. lbs. of butterfat produced daily per cow	0.92	0.91	0.98	0.99	0.95	0.95	1.15	1.15	1.06	1.02	1.10	1.09
Ave. percentage fat in milk	3.54	3.53	3.59	3.60	3.57	3.57	3.55	3.58	4.08	4.05	3.82	3.82
Ave. lbs. 4 per cent milk** produced daily	24.2	24.0	25.6	25.9	24.9	25.0	30.3	30.1	26.3	25.4	28.3	27.8
Ave. body weight per cow at beginning (pounds)	1159	1159	1243	1250	1201	1205	1136	1140	1220	1228	1178	1184
Ave. gain per cow in body weight per 24-day period	5.0	9.6	7.5	13.5	6.3	11.6	-4.0	-2.7	-7.3	-3.4	-5.7	-3.1
Ave. lbs. digestible crude protein consumed daily per cow†	2.69	2.52	2.77	2.71	2.73	2.62	2.88	2.79	2.89	2.71	2.89	2.75
Ave. lbs. total digestible nutrients consumed daily per cow†	16.2	16.5	16.8	17.4	16.5	17.0	18.8	19.3	18.8	18.3	18.8	18.8
Ave. lbs. of digestible crude protein per 100 lbs. 4% milk	11.1	10.5	10.8	10.5	11.0	10.5	9.5	9.3	11.0	10.7	10.3	10.0
Ave. lbs. of total digestible nutrients per 100 lbs. 4% milk	66.9	68.8	65.6	67.2	66.3	68.0	62.0	64.1	71.5	72.0	66.8	68.1

*Six Holsteins and two Jerseys during 1929-30 and six Holsteins and four Jerseys during 1930-31.

**"Fat-Corrected Milk," Bulletin No. 245, Ill. Agr. Expt. Sta.

†Computed from chemical analyses in Table IV and digestion coefficients in "Feeds and Feeding" by Henry and Morrison, 1925, except pea meal coefficient taken from Wash. Agr. Expt. Sta., Bul. 287.