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A CONTRIBUTION TO THE STUDY OF THE ECONOMIES OF
MILK PRODUCTION.

Bulletins of this Station will be sent upon application, free of charge,
to any Farmer in the State.

KNOXVILLE, TENNESSEE, U. S. A.

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DIVISION OF FIELD AND FEEDING EXPERIMENTS.

A CONTRIBUTION TO THE STUDY OF THE ECONOMIES OF MILK PRODUCTION.

BY C. F. VANDERFORD.

The feeding experiments hereinafter detailed were arranged and carried out:

1. To compare results of feeding such a grain ration as can be produced upon the ordinary Tennessee farm with results of feeding a ration of materials to be purchased, in whole or in part, in market; in other words, to determine the comparative economy of feeding home-grown stuff or of exchanging a part of the products of the farm for other materials of higher nutritive values.
2. To determine the average feed-cost of milk produced by cows of different breeds under like conditions and management.
3. To compare the producing capacity of full bred and of grade cows fed a like ration per 1,000 pounds live weight.

Sixteen cows, of which six were Jerseys, two Holsteins and eight grades, were selected for the experiment. The cows were divided into two classes, so that the two should be as closely as possible of equal merit as to breeding, and as nearly as might be of the same total live weight, total daily yield of milk, and number of days in milk, at beginning of test.

The eight cows of class A averaged 5 years 3 months of age, 92 days in lactation, and were giving at beginning of test 139.81 pounds of milk daily. The eight cows of class B averaged 5 years 6 months of age, 90 days in lactation, and were giving 143.87 pounds of milk daily at beginning of test.

CLASS A.—8 COWS.

No.	Name of Cow	Breed	Age, Years	Last Calf Dropped	Daily yield of Milk at beginning of Tests, Pounds.
1	Annie Signal.....	Jersey	6	October 24, 1891...	33.62
2	Richland Daisy	Jersey	4	September 3, 1891	15.05
3	Iuka	Jersey	6	August 17, 1891 ..	12.25
4	Sister	Grade Jersey...	3	October 2, 1891	10.93
5	Spotty	Grade Jersey...	6	August 5, 1891	14.65
6	Mary.....	Grade Holstein	3	August 1, 1891.....	19.30
7	Queen.....	Grade Holstein	11	July 25, 1891	20.10
8	Aagie Lucille 2d.....	Holstein	3	August 3, 1891.....	15.21

CLASS B.—8 COWS.

9	Mamelle	Jersey	7	September 3, 1891	15.80
10	Patti	Jersey	5	August 25, 1891.....	14.71
11	Rosa.....	Jersey	10	June 20, 1891.....	11.81
12	Parker	Grade Jersey...	6	September 8, 1891	24.64
13	May	Grade Jersey...	6	October 21, 1891...	21.56
14	Ella	Grade Jersey...	3	August 18, 1891.....	14.10
15	Eva.....	Grade Holstein	3	September 3, 1891	22.16
16	Filices	Holstein	4	August 21, 1891.....	19.09

On the 21st day of November, 1891, silo No. 1, sorghum and pea-vines, was opened, and this ensilage was fed during the first period of the test. The station herd was at this time put upon winter feed, and a preliminary period of five days was allowed to prepare the cows of Classes A and B for the experiment. The results for the first period of 35 days, beginning November 26 and ending December 30, are given in Tables I and II.

During this first period of thirty-five days, the daily ration consumed by the cows of Class A was, for each 1,000 pounds of live weight, 30 pounds of ensilage (sorghum and pea-vines), valued at \$2 per ton of 2,000; 5.22 pounds of hay (mixed, as produced on the farm), valued at \$8 per ton; 3 pounds of cotton-seed meal, cost \$24 per ton; and 5 pounds of wheat bran, cost \$20 per ton. Cost per daily ration, for each 1,000 pounds live weight, 13.69 cents.

For the same period the daily ration consumed by the cows of Class B was, for each 1,000 pounds of live weight, 30 pounds of ensilage, 5.12 pounds of hay, and 10 pounds of a mixture of equal

weights of corn and oats ground together of value \$18 per ton. Cost per daily ration, per 1,000 pounds live weight, 14.05 cents.

The herd was milked and fed at 3:30 A. M. and 2 P. M. throughout the test. Frequent determinations of the per cent. of butter-fat were made, using the Babcock tester, the average results of which are given in the tables. No butter was made; the entire milk product was sold to customers in the city of Knoxville.

The live weights given in the tables were ascertained by three weighings on consecutive days as the cows were turned out of the barn at about 3 P. M.

I.—FIRST PERIOD—35 DAYS, NOVEMBER 26 TO DECEMBER 30, 1891.

No.	Name of Cow	Daily Yield of Milk. Pounds.	Average per cent. of Butter-fat	Live Weight Nov. 26.	Live Weight Dec. 30.	Days in Lactation at begini'g of Tests
1	Annie Signal.....	32.45	5.16	952	955	32
2	Richland Daisy.....	15.70	6.08	785	733	83
3	Iuka.....	12.96	5.68	680	685	100
4	Sister.....	10.16	6.20	860	852	54
5	Spotty.....	15.83	5.38	810	795	112
6	Mary.....	21.66	3.20	905	940	116
7	Queen.....	20.56	4.25	925	908	123
8	Aagie Lucille 2d...	16.81	3.82	705	785	114
		146.13	4.82	6622	6653	
9	Mamelle.....	12.79	5.64	865	865	83
10	Patti.....	16.09	6.25	725	690	92
11	Rosa.....	14.26	4.30	830	830	158
12	Parker.....	24.73	3.20	845	800	78
13	May.....	22.76	4.24	950	925	35
14	Ella.....	16.28	2.90	760	775	99
15	Eva.....	23.40	3.30	930	925	83
16	Filices.....	21.88	3.15	1000	1040	96
		152.19	3.96	6905	6850	

II.—FIRST PERIOD—35 DAYS, NOVEMBER 26 TO DECEMBER 30, 1891.

No.	Name of Cow	Cost of Feed 35 Days Dollars	Total Pounds of Milk	Feed cost per gallon of Milk. Cents.	Total Pounds Butter-fat	Feed cost per pound of Butter-fat (cents)
1	Annie Signal.....	4 86	1,135.75	3.67	58.60	8.29
2	Richland Daisy.....	4 02	549.50	6.27	33.41	12.03
3	Iuka	3 44	453.50	6.49	25.76	13.35
4	Sister	4 02	355.56	9.69	22.04	18.24
5	Spotty	4 02	554.00	6.23	29.81	13.49
6	Mary	4 23	758.13	4.78	24.26	17.44
7	Queen	4 23	719.56	5.04	30.58	13.86
8	Aagie Lucille 2d...	3 44	588.50	5.01	22.48	15.30
		32 26	5,114.50	5.41	246.94	13.10
9	Mamelle	4 36	447.50	8.35	25.24	17.27
10	Patti	3 50	563.06	5.33	35.19	9.95
11	Rosa	4 16	499.00	7.14	21.46	19.38
12	Parker	4 36	865.44	4.32	27.69	15.75
13	May	4 36	796.69	4.69	33.78	12.91
14	Ella	3 50	569.81	5.26	16.52	21.19
15	Eva	4 36	819.06	4.56	27.03	16.87
16	Filices	4 92	766.13	5.50	24.13	20.39
		33 52	5,326.69	5.39	211.04	15.88

During the second period of thirty-five days, the daily ration consumed by the cows of Class A was, for each 1,000 pounds of live weight, 30.46 pounds of ensilage of corn, valued at \$2 per ton; 6.04 pounds of mixed hay, valued at \$8 per ton; and 10 pounds of equal weights of corn and oats ground together, valued at \$19 per ton. Cost for daily ration, per 1,000 pounds live weight, 14.96 cents.

For the same period the daily ration consumed by the cows of Class B was, for each 1,000 pounds of live weight, 28.75 pounds of ensilage; 5.9 pounds of mixed hay; 3 pounds of cotton-seed meal, at \$24 per ton; and 5 pounds of wheat bran, at \$21 per ton. Cost per daily ration, for 1,000 pounds live weight, 14.08 cents.

III.—SECOND PERIOD—35 DAYS, DEC. 31, 1891, TO FEBRUARY 3, 1892.

No.	Name of Cow.	Daily Yield of Milk Pounds.	Average per cent. of Butter-fat.	Live Weight Dec. 30, '91.	Live Weight Feb. 3, '92.	Days in Lactation at beginni'g of Test
1	Annie Signal.....	27.32	4.57	955	915	67
2	Richland Daisy.....	13.67	5.78	733	735	118
3	Iuka	11.27	5.90	635	685	135
4	Sister	7.71	4.96	852	910	89
5	Spotty	15.13	4.85	795	825	147
6	Mary	19.50	3.48	940	960	151
7	Queen	18.87	4.35	908	870	158
8	Aagie Lucille 2d....	16.00	2.98	785	750	149
		129.47	4.47	6653	6650	
9	Mamelle	14.02	5.77	865	915	115
10	Patti	12.62	6.43	690	690	125
11	Rosa	8.31	5.33	830	835	193
12	Parker	20.50	4.22	800	805	113
13	May	20.44	4.52	925	935	70
14	Ella.....	15.33	3.48	775	788	134
15	Eva.....	20.78	3.18	925	960	115
16	Filices	20.79	3.00	1040	1107	131
		132.79	4.26	6850	7035	

IV.—SECOND PERIOD—35 DAYS, DEC. 31, 1891, TO FEB. 3, 1892.

No.	Name of Cow.	Cost of Feed, 35 Days. Dollars.	Total Pounds of Milk	Feed cost per gallon of Milk. Cents	Total Pounds of Butter-fat	Feed cost per pound of Butter-fat. Cents
1	Annie Signal	5.08	956.19	4.55	43.71	11.62
2	Richland Daisy.....	4.28	478.56	7.66	27.66	15.47
3	Iuka	3.75	394.37	4.60	23.27	16.11
4	Sister	4.48	270.00	14.22	13.39	33.46
5	Spotty	4.50	529.63	7.28	25.69	17.52
6	Mary	4.49	682.44	5.64	23.75	18.90
7	Queen	4.48	660.56	5.81	28.73	15.59
8	Aagie Lucille 2d...	3.76	559.69	5.76	16.68	17.09
		34.82	4,531.44	6.58	202.88	17.16
9	Mamelle	4.07	490.56	7.11	28.30	14.38
10	Patti	3.36	441.63	6.52	28.40	11.83
11	Rosa	4.07	290.87	11.99	15.50	26.26
12	Parker	4.25	717.56	5.08	30.28	14.03
13	May	4.07	715.31	4.88	32.33	12.59
14	Ella.....	3.35	536.63	5.35	18.67	17.94
15	Eva.....	4.26	727.44	5 02	23.13	18.42
16	Filices	4.88	727.75	5.75	21.83	22.35
		32.31	4,647.75	5.96	198.44	16.28

Analyses of the ensilage used in the experiment were made by the Station Chemist. For the cotton-seed meal the analysis by J. B. McBryde, given below, was used. The nutritive values of all other feed stuffs employed were estimated from averages of analyses as stated in the compilation of Dr. Jenkins, published 1891.

I.—ANALYSIS OF ENSILAGE OF PEA VINES AND SORGHUM.

(J. B. McBryde, Asst. Chemist.)

Moisture		67.99
Dry Matter		32.01
		100.00
Proteins.....	2.98	Dry Matter. 9.31
Crude fat.....	1.80	5.63
Nitrogen—free Extract...	16.55	51.70
Crude fiber.....	7.11	22.21
Ash.....	3.57	11.15
		32.01
		100.00

2.—ANALYSIS OF ENSILAGE OF CORN.

(J. B. McBryde, Asst. Chemist.)

Moisture		81.45
Dry Matter.....		18.55
		100.00
Proteins.....	1.18	Dry Matter. 6.36
Crude fat.....	1.06	5.72
Nitrogen—free Extract...	9.19	49.51
Crude fiber.....	5.65	30.46
Ash.....	1.47	7.95
		18.55
		100.00

3.—*ANALYSIS OF COTTON-SEED MEAL.

(J. B. McBryde, Asst. Chemist.)

Moisture.....		7.47
Dry Matter.....		92.53
		100.00
Proteins.....	47.30	Dry Matter. 51.12
Crude fat.....	9.26	10.01
Nitrogen—free Extract...	24.40	26.37
Crude fiber.....	4.53	4.90
Ash.....	7.04	7.60
		92.53
		100.00

The nutritive values of the rations fed may be stated as follows:
FIRST PERIOD, CLASS A.

	Dry Matter.	DIGESTIBLE.	
		Proteins.	Carb.-hydrates.
30 lbs. Ensilage (Sorghum and Pea-Vines)	9.60	0.67	6.19
5.22 pounds Hay.....	4.41	0.19	2.38
3 pounds Cotton-seed Meal.....	2.78	1.21	1.43
5 pounds Wheat Bran.....	4.39	0.59	2.56
		21.18	12.56
		2.66	

Nutritive ratio, 1: 4.7.

FIRST PERIOD, CLASS B.

	Dry Matter.	DIGESTIBLE. Proteins.	Carb.-hydrates.
30 lbs. Ensilage (Sorghum and Pea-Vines)	9.60	0.67	6.19
5.12 pounds Hay	4.33	0.18	2.33
5 pounds Corn	8.93	0.86	6.62
5 pounds Oats			
ground together			
	22.86	1.71	15.14

Nutritive ratio, 1: 8.9.

SECOND PERIOD, CLASS A.

	Dry Matter.	DIGESTIBLE. Proteins.	Carb.-hydrates.
30.46 pounds Ensilage (corn)	5.65	0.27	3.64
6.04 pounds Hay	5.10	0.21	2.74
5 pounds Corn	8.93	0.86	6.64
5 pounds Oats			
ground together			
	19.68	1.34	13.02

Nutritive ratio, 1: 9.7.

SECOND PERIOD, CLASS B.

	Dry Matter.	DIGESTIBLE. Proteins.	Carb.-hydrates.
28.75 pounds Ensilage (corn)	5.33	0.25	3.44
5.9 pounds Hay	4.98	0.21	2.69
3 pounds Cotton-seed Meal	2.78	1.21	1.43
5 pounds Wheat Bran	4.39	0.59	2.56
	17.48	2.26	10.12

Nutritive ratio, 1: 4.5

The space at disposal for this Bulletin does not permit a careful discussion of the figures here presented. It may be suggested, however, that we have in the results of this test some reason to believe that, while the conclusions of Dr. Emil Wolff can be very safely followed as guides for further experiment, they cannot be accepted as standards under all conditions.

During the first period of thirty-five days, the eight cows of Class A consumed

		Nitrogen. (N)	Phos. Acid. (P ₂ O ₅)	Potash. (K ₂ O)
7,000 pounds Ensilage (Sorghum and Pea-vines)	containing	33.60	8.40	34.30
1,480 pounds Hay	"	18.50	6.96	30.78
686.25 pounds Cotton-seed Meal	"	41.38	17.02	11.60
1,093.75 pounds Wheat Bran	"	27.12	33.14	17.06
		120.60	65.52	93.74
And gave 5,114.5 pounds of milk,	containing	35.80	15.30	8.70
		84.80	50.22	85.04

As the live weight of the eight cows had increased during the thirty-five days less than one-half of one per cent., it may be assumed that, of the manurial value of the food consumed by them, only that contained in the milk, all of which was sold, was lost to the farm.

During the first period the eight cows of Class B consumed

	Nitrogen. (N)	Phos. Acid. (P ² O ₅)	Potash. (K ² O)
7,000 pounds Ensilage (Sorghum) and Pea-vines).....} containing.....	33.60	8.40	34.30
1,480 pounds Hay.....	18.50	6.96	30.78
1,129.6 pounds Corn.....	19.88	7.68	4.52
1,129.6 pounds Oats.....	21.80	8.02	5.87
	93.78	31.06	75.47
And gave 5,326.7 pounds of milk, containing	37.39	15.98	9.00
	56.39	15.08	66.47
The cost of feed for first period for Class A was.....			\$32 26
The value of the manure, assuming nitrogen at 17 cents, phosphoric acid at 6 cents, and potash at 5 cents per pound, was.....			21 67
Making <i>net</i> feed cost of 5,114.5 pounds of milk, or 1.77 cents per gallon of 8.57 pounds.....			\$10 59
The cost of feed for first period for Class B was.....			\$33 52
The value of the manure was.....			13 81
Making <i>net</i> for cost of 5,326.7 pounds of milk, or 3.17 cents per gallon			\$19 71

During the second period of the feeding experiment the cows of Class A were fed the grain ration given to cows of Class B during the first period, and *vice versa*. It was necessary to use corn ensilage of rather inferior quality. The poor quality of this corn ensilage was due to the fact that the growing corn was left too thick upon the ground, and made but little grain.

The eight cows of Class A consumed

	Nitrogen.	Phos. Acid.	Potash.
7,043.65 pounds of Corn Ensilage, containing.....	13.38	6.33	22.54
1,480 pounds of Hay.....	18.50	6.96	30.78
1,150.62 pounds of Corn.....	20.25	7.82	4.60
1,150.62 pounds of Oats.....	22.21	8.17	5.98
	74.34	29.28	63.90
And gave 4,531.4 pounds of milk, containing.....	31.72	13.59	7.66
	42.62	15.69	56.24

The cows of Class B consumed during the second period

	Nitrogen.	Phos. Acid.	Potash.
7,043.75 pounds of Corn Ensilage, containing.....	13.38	6.33	22.54
1,480 pounds of Hay.....	18.50	6.96	30.78
686.25 pounds of Cotton-seed Meal	41.38	17.02	11.60
1,093.75 pounds of Wheat Bran.....	27.12	33.14	17.06
	100.38	63.45	81.98
And gave 4,647.7 pounds of milk, containing.....	32.53	13.94	7.85
	67.85	49.51	74.13

The cost of feed for second period for Class A was..... \$34 82
The value of the manure was..... 11 00

Making *net* feed cost of 4,531.4 pounds of milk, or 4.5 cents per gallon
of 8.57 pounds..... \$23 82

The cost of feed for second period of Class B was.....	\$32 31
The value of the manure was.....	18 21
Making <i>net</i> feed cost of 4,647.7 pounds of milk, or 2.6 cents per gallon	\$14 10
Yield of milk of the sixteen cows first 35 days.....	10.441 pounds.
“ “ “ “ “ second 35 days.....	9.179 “
Total cost of feed of the sixteen cows first 35 days.....	\$65 78
“ “ “ “ “ second 35 days.....	67 13
<i>Net</i> “ “ “ “ “ first 35 days.....	30 30
“ “ “ “ “ second 35 days.....	37 92
Total live weight of the sixteen cows at beginning of experiment	13,527 pounds.
“ “ “ “ “ “ end of 70 days.....	13,685 “

The cows of the entire herd were in excellent health and condition throughout.

In the Tables II and IV, the totals of butter-fat were calculated from the percentages ascertained by frequent tests with the Babcock tester. The average of butter-fat in butter being taken at 84.39 per cent.,* one pound of butter-fat represents 1.185 pounds of butter. During the 70 days, if the milk had been converted into butter, the total product would have been 1,018.27 pounds. As no appreciable quantity of nitrogen, phosphoric acid or potash is contained in butter, the *net* feed-cost might be taken for naught.

A few practical conclusions may be fairly stated:

Dairying in Tennessee, whether for milk production or for butter making, can be made highly profitable, under good management.

For winter dairying the silo is indispensable.

It *pays* to purchase, at ordinary market prices, such food stuffs as cotton-seed meal and wheat bran, not only to increase the product of the dairy, but as a means of maintaining, and, when butter alone is sold, of increasing the fertility of the farm.

It will always pay the dairyman to weigh and to test carefully the product of each cow of his herd, so that he may know how and whence his profits or his losses come.

*Average of 302 analyses of butter. Chemische Zusammensetzung der menschlichen Nahrungs- und Genussmittel. Dr. J. König. Berlin, 1889.—p. 369.