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# A Contribution to the Study of the Economies of Milk Production

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# BULLETIN

OF THE

# AGRICULTURAL EXPERIMENT STATION

OF THE

## UNIVERSITY OF TENNESSEE

STATE AGRICULTURAL AND MECHANICAL COLLEGE.

VOL. V. JULY, 1892. No. 3.


## 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.

# THE AGRICULTURAL EXPERIMENT STATION

## OF THE UNIVERSITY OF TENNESSEE.

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☞ The Experiment Station building, containing its offices, laboratories and museum, and the plant-house and horticultural department, are located on the University grounds, fifteen minutes walk from the Custom House in Knoxville. The Experiment farm, stables, milk laboratory, etc., are located one mile west of the University, on the Kingston pike. Farmers are cordially invited to visit the buildings and experimental grounds.

# 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 | 13.91 |

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 | 85 |
| 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 begini'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 | 198 |
| 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 |

| | | Dry Matter. |
|---|---|---|
| Proteins | 2.98 | 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 |

| | | Dry Matter. |
|---|---|---|
| Proteins | 1.18 | 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 |

| | | Dry Matter. |
|---|---|---|
| Proteins | 47.30 | 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 | 2.66 | 12.56 |

Nutritive ratio, 1 : 4.7.

*Bulletin, No. 5, Vol. IV. Tenn. Exp. Station.

During the first period the eight cows of Class B consumed

| | | Nitrogen. (N) | Phos. Acid. ($P^2O^5$) | Potash. ($K^2O$) |
|---|---|---|---|---|
| 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 *net* 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 *net* 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 *net* 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 |
| *Net* " " " " " 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. Konig. Berlin, 1889.—p. 369.

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