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Percentage of fat in the cow's milk.

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CORRELATION BETWEEN THE PERCENTAGE OF FAT IN COW'S MILK AND THE YIELD

BY

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CORRELATION BETWEEN THE PERCENTAGE OF FAT IN COW'S MILK AND THE YIELD¹

By ELMER ROBERTS

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INTRODUCTION

It is a generally accepted opinion that cows with a large yield of milk produce a smaller percentage of fat than do cows with a small yield of milk. Stated in another way, it is thought that low-yielding cows produce a higher percentage of fat than that produced by high-yielding cows.

To what extent this is true or not true has not up to the present time been demonstrated by a careful statistical investigation. Wilson² from a study of the records of 2,866 Ayrshire cows concluded that quantity and quality (yield of milk and percentage of fat) were independent of each other. He states:

If we group together all the low-yielding cows, and find their milk invariably high in quality, we may infer that low yield and high quality are of the nature of concomitant variations. If we group the high-yielding cows together, and find their milk invariably of low quality, we may infer that high yield and low quality run together. But if we take these groups and any other groups we can form, and find that the quality varies the same way in them all—that is that there are low qualities, high qualities, and medium qualities in every one of them—then we are justified in inferring that the quantity and quality of the milk are independent of each other. And this is what we do find.

In a criticism of this work Pearson,³ by means of a correlation table, showed that there was a small but significant decrease in the percentage of fat with an increase in the yield of milk, and pointed out the fallacy of such a process of reasoning in connection with statistical data.

¹ Paper No. 5 from the Laboratory of Genetics, Agricultural Experiment Station of the University of Illinois.

² WILSON, James. THE SEPARATE INHERITANCE OF QUANTITY AND QUALITY IN COWS' MILK. *In* Sci. Proc. Roy. Dublin Soc., n. s., v. 12, no. 33, p. 470-479, 6 diagr. 1910.

³ PEARSON, Karl. NOTE ON THE SEPARATE INHERITANCE OF QUANTITY AND QUALITY IN COWS' MILK. *In* Biometrika, v. 7, No. 4, p. 548-550. 1910.

Wilson did not handle his data in such a way as to bring out the relationship which exists between the quantity and quality. In "The Principles of Stock-Breeding," Wilson¹ again writes:

In connection with yield and quality in milk, it has been assumed, frequently, that the two characters are interdependent: that when the one is high the other must be low. It has been found that this is not so. The characters are independent and have no effective influence upon each other. High quality of milk is found among cows giving all kinds of yield, and low quality is found similarly.

It seemed to the writer that it might be of some value to make a more careful statistical investigation of this question with our American cattle.

SOURCE OF DATA

In the registers of the different American associations is to be found a large body of data which furnished the major part of the material for this investigation. There are involved in this study the following: 2,141 yearly tests of Jerseys, Register of Merit, 1911, 1913; 3,564 Guernseys, Guernsey Breeders' Journal, May, 1915; 1,925 Holstein-Friesians, Holstein-Friesian Advanced Register Year Book, volumes 21-26; 1,091 Ayrshires, Year Book of the Ayrshire Breeders' Association, 1907, 1911, 1913, 1914; 98 Ayrshires²; 750 grade Jerseys³ and 341 grade Holstein-Friesians⁴; and 2,002⁴ yearly tests of cows unclassified as to breed.

Only the yearly tests were used for the reason that a yearly record is a more reliable criterion of a cow's performance and ability than a shorter test. It should be pointed out here, that in the case of the records from the associations, selected groups of individuals are involved in this study, since only selected individuals are subject to entry in the registers of the associations.

The method of finding the relation between the percentage of fat and the yield of milk is by means of the correlation table. The cows are grouped, according to age when the test began, into the following groups: 2 to 3 years, 3 to 4 years, 4 to 5 years, and 5 years and over. The last group comprises what are usually held to be mature cows. These are not exact divisions according to age, since a given group may contain individuals differing in age by almost a year. For example, the 3-to-4-year group contains those cows with tests beginning at some time after they were 3 and before they were 4 years old. A cow with a test beginning the day she was 3 would be practically a year younger than one having a test starting when she was one day under 4, though both would be classed in the same group. Of course, there are few cases of this kind.

¹ WILSON, James. THE PRINCIPLES OF STOCK-BREEDING. p. 121-122. London, 1912.

² Furnished by Mr. C. M. Winslow, Secretary of the Ayrshire Breeders' Association.

³ Obtained from Mr. W. W. Yapp, Illinois Agricultural Experiment Station.

⁴ Obtained from Prof. W. J. Fraser, Illinois Agricultural Experiment Station.

POSSIBLE SOURCES OF ERROR

In some of the breeds, Jersey and Guernsey, a yearly test consists of any 365 consecutive days. This may cover parts of two lactation periods, which is not a serious objection, since the study is interested in the relation between the percentage of butter fat and yield of milk in groups of individuals and not in the individual herself. In other words, the question is to what extent, if any, do cows with large milk yield tend to show a low percentage of fat, or cows with a low milk yield to show a high percentage. The Ayrshire Association specifies both the amount of milk and butter fat necessary for entrance. In the other associations only the butter-fat yield is specified. Unless the requirements of the Ayrshire Association are in accordance with the natural relation of butter-fat and milk yield, one would expect to find abnormal results in such a selected group, which would not hold for Ayrshire cattle in general. This point will be treated more fully later in this paper. For the grade Jerseys, grade Holstein-Friesians, and cows unclassified as to breed, it should be pointed out that the populations are composed of a heterogeneous lot, and whatever results are found will apply only to such mixed populations.

ANALYSIS OF DATA

JERSEY

Tables I to IV show, in the form of correlation tables, the distribution of individuals with regard to the yield of milk and the percentage of fat. Table V contains all the tests of Jerseys regardless of age and was made by combining Tables I to IV. Text Table A summarizes the means, standard deviations, coefficients of variability of milk and fat, and the correlation between the percentage of fat and the yield for Jerseys of different ages, and for Jerseys, irrespective of age.

TABLE A.—*Summary of results from a study of the correlation between the percentage of fat and yield of milk for Jerseys*

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	877	Milk.....	6,475.0 ± 28.9	1,270.5 ± 20.5	19.62 ± 0.33	-0.360 ± 0.020
		Fat.....	5.425 ± 0.012	0.517 ± 0.008	9.52 ± 0.15	
3 to 4.....	411	Milk.....	7,325.0 ± 45.8	1,377.5 ± 32.4	18.81 ± 0.46	-0.437 ± 0.027
		Fat.....	5.401 ± 0.019	0.562 ± 0.013	10.41 ± 0.25	
4 to 5.....	219	Milk.....	8,043.4 ± 60.7	1,332.5 ± 42.9	16.57 ± 0.55	-0.359 ± 0.040
		Fat.....	5.462 ± 0.024	0.533 ± 0.017	9.76 ± 0.32	
5 and over.....	634	Milk.....	8,814.5 ± 43.1	1,608.5 ± 30.5	18.25 ± 0.35	-0.397 ± 0.023
		Fat.....	5.322 ± 0.013	0.502 ± 0.010	9.44 ± 0.18	
All ages.....	2,141	Milk.....	7,491.4 ± 25.0	1,718.0 ± 17.7	22.93 ± 0.25	-0.354 ± 0.013
		Fat.....	5.392 ± 0.008	0.525 ± 0.005	9.74 ± 0.10	

The correlation is negative and very significant for all ages. When judged by their probable errors, there are no significant differences among the correlations for the different groups.

The milk yield increases from an average of 6,475 pounds for the 2-to-3-year-old class to 8,814.5 pounds for the mature class (fig. 1). Since

FIG. 1.—Graphs showing the averages of the milk yield for the different ages of cows.

there is a marked negative correlation between the percentage of fat and yield at all ages, one might look for the percentage of fat to decrease as the yield of milk increases with the age of the cows. The class which is 5 years and over shows a slightly smaller percentage of fat, but the 4-to-5-year-old class has a higher percentage than the

3-to-4-year-old class, though the difference is not significant (fig. 2). On the whole, the percentage remains practically the same. This may be due to the relatively stable relation between the amount of fat and yield throughout the growing period of the individual cow. Holdaway¹ found this to be true for Holstein-Friesians, using the 7-day records. Stated in another way, the percentage of fat seems to be fairly constant throughout the life of a given individual, but different individuals show differing percentages of fat. The results show that at a given age cows with a high milk yield tend to produce a lower percentage of

FIG. 2.—Graphs showing the averages of percentages of butter fat for different breeds of cows.

fat than do cows with a low milk yield. This is expressed by the negative correlations obtained. Table B illustrates in another way that this is true. This table is the result of arbitrarily dividing Table II into three parts, cows yielding 4,500 to 6,500, those yielding 7,000 to 9,000,

¹ HOLDAWAY, C. W. STATISTICAL WEIGHTING FOR AGE OF ADVANCED REGISTRY COWS. *In Amer. Nat.*, v. 50, no. 599, p. 676-687, 2 fig. 1916.

and those yielding 9,500 to 13,000 pounds of milk, and finding the average yield of milk and percentage of fat. The decrease from 5.657 per cent for the first group to 4.941 per cent for the third group is very significant. Any group of cows showing a negative correlation between percentage of fat and yield of milk would give, in general, the same results if treated as was Table II.

TABLE B.—*Milk yield and percentage of butter fat of Jerseys 3 to 4 years of age*

Number of animals.	Extremes of milk yield.	Average milk yield.	Average percentage of fat.
	Pounds.	Pounds.	
152.....	4,500-6,500	6,049.3	5.657
220.....	7,000-9,000	7,677.3	5.307
39.....	9,500-13,000	10,307.7	4.941

GUERNSEY

Tables VI to IX show the distribution of individuals with regard to the yield of milk and the percentage of butter fat, in the form of correlation tables. Table X combines Tables VI to IX. Table C gives the means, standard deviations, coefficients of variability of milk and fat, and the correlation between the percentage of fat and yield of milk for Guernseys of different ages.

TABLE C.—*Summary of results from a study of the correlation between the percentage of fat and yield of milk for Guernseys*

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	1,375	Milk.....	7,608.0 $\pm$ 28.8	1,584.0 $\pm$ 20.4	20.82 $\pm$ 0.77	-0.251 $\pm$ 0.017
		Fat.....	5.065 $\pm$ 0.008	0.458 $\pm$ 0.006	9.03 $\pm$ 0.32	
3 to 4.....	644	Milk.....	8,317.0 $\pm$ 49.3	1,854.0 $\pm$ 34.8	22.29 $\pm$ 0.44	-0.289 $\pm$ 0.024
		Fat.....	5.080 $\pm$ 0.013	0.477 $\pm$ 0.009	9.39 $\pm$ 0.18	
4 to 5.....	478	Milk.....	9,247.0 $\pm$ 62.6	2,030.0 $\pm$ 44.3	21.95 $\pm$ 0.50	-0.264 $\pm$ 0.029
		Fat.....	5.046 $\pm$ 0.014	0.462 $\pm$ 0.010	9.13 $\pm$ 0.20	
5 and over.....	1,067	Milk.....	9,893.0 $\pm$ 42.8	2,067.5 $\pm$ 30.2	20.90 $\pm$ 0.68	-0.337 $\pm$ 0.018
		Fat.....	4.956 $\pm$ 0.010	0.478 $\pm$ 0.007	9.64 $\pm$ 0.30	
All ages.....	3,564	Milk.....	8,644.4 $\pm$ 23.7	2,095.4 $\pm$ 16.7	24.24 $\pm$ 0.20	-0.296 $\pm$ 0.010
		Fat.....	5.033 $\pm$ 0.005	0.471 $\pm$ 0.004	9.35 $\pm$ 0.08	

The correlation coefficients are negative as in the case of the Jerseys, but slightly smaller. For the Jerseys they range from -0.359 ± 0.040 to -0.437 ± 0.027 , while for the Guernseys the range is from -0.251 ± 0.017 to -0.337 ± 0.018 . The yield of milk gradually increases from an average of 7,608 pounds for the 2-to-3-year-old class to 9,893 for the group which is 5 years and over. The average percentage of fat varies from 4.956 ± 0.010 for the group which is 5 years and over to 5.080 ± 0.013 for the 3-to-4-year-old class. (See fig. 2.)

HOLSTEIN-FRIESIAN

Tables XI to XIV exhibit the distributions of individuals with regard to the yield of milk and the percentage of fat in the form of correlation tables. Table XV combines Tables XI to XIV. Table D summarizes the means, standard deviations, coefficients of variability for milk and fat, and the correlations between percentage of fat and yield for Holstein-Friesians of different ages.

TABLE D.—Summary of results from a study of the correlation between the percentage of fat and yield of milk for Holstein-Friesians

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	610	Milk.....	12,488.5 ± 80.4	2,942.0 ± 56.8	23.56±0.48	-0.116±0.027
		Fat.....	3.462± 0.008	0.294± 0.006	8.50±0.16	
3 to 4.....	341	Milk.....	13,938.5 ± 116.5	3,188.0 ± 82.4	22.87±0.62	-0.160±0.039
		Fat.....	3.433± 0.012	0.322± 0.008	9.38±0.24	
4 to 5.....	292	Milk.....	14,825.5 ± 124.4	3,151.0 ± 87.9	21.25±0.62	-0.088±0.039
		Fat.....	3.417± 0.012	0.313± 0.009	9.17±0.26	
5 and over....	682	Milk.....	16,280.0 ± 94.4	3,654.5 ± 66.7	22.45±0.43	-0.115±0.026
		Fat.....	3.420± 0.008	0.301± 0.006	8.81±0.16	
All ages.....	1,925	Milk.....	14,443.1 ± 56.0	3,640.7 ± 39.6	25.21±0.29	-0.133±0.015
		Fat.....	3.435± 0.005	0.305± 0.003	8.88±0.10	

The correlations are much smaller for the Holstein-Friesian than for the two preceding breeds. They range from -0.088 ± 0.039 to -0.160 ± 0.036 . The first is not significant when judged by the probable error. The milk yields increase regularly from 12,488 pounds for the youngest class to 16,280 for the oldest. The percentages of fat remain practically constant for the different ages. (See fig. 2.)

AYRSHIRE

Tables XVI to XIX are correlation tables for the different classes of Ayrshires. Table E gives means, standards deviations, coefficients of variability for milk and fat, and the correlations between percentages of fat and yield of milk.

TABLE E.—Summary of results from a study of the correlation between the percentage of fat and yield of milk for Ayrshires

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	343	Milk.....	7,960.5 ± 47.9	1,314.5 ± 33.9	16.51±0.44	+0.019±0.036
		Fat.....	4.016± 0.011	0.310± 0.008	7.71±0.20	
3 to 4.....	192	Milk.....	9,179.5 ± 86.1	1,769.5 ± 60.9	19.28±0.69	-0.093±0.048
		Fat.....	3.936± 0.014	0.314± 0.011	6.35±0.28	
4 to 5.....	160	Milk.....	9,584.5 ± 83.5	1,566.5 ± 59.1	16.34±0.63	-0.023±0.053
		Fat.....	3.919± 0.016	0.303± 0.011	7.73±0.29	
5 and over....	396	Milk.....	10,726.0 ± 67.1	1,980.0 ± 47.5	18.46±0.46	-0.047±0.034
		Fat.....	3.865± 0.011	0.313± 0.008	8.10±0.19	
All ages.....	1,091	Milk.....	9,417.1 ± 41.7	2,044.4 ± 29.5	21.71±0.33	-0.138±0.020
		Fat.....	3.933± 0.006	0.318± 0.005	8.08±0.12	

In no one of the four groups classified as to age is there a significant correlation, meaning that for these classes of individuals studied the milk yield and percentage of fat are independent. It is curious that this breed should have a different relation existing between fat and milk than that of the Jerseys, Guernseys, and Holstein-Friesians. This result is probably due to the fact that they are a much more highly selected group of individuals than in the case of any of the other breeds, owing to the requirements for registry imposed by the Ayrshire Association. The minimum requirements are as follows:

Age.	Weight of milk.	Weight of fat.
<i>Years.</i>	<i>Pounds.</i>	<i>Pounds.</i>
2 to 3.....	6,000	214.3
3 to 4.....	6,500	236.0
4 to 5.....	7,500	279.0
5 and over.....	8,500	322.0

This would mean that upon the basis of these specified amounts the percentages of fat for the different ages would be as follows:

2 to 3 years.....	3.572
3 to 4 years.....	3.631
4 to 5 years.....	3.720
5 years and over.....	3.788

A gradual increase in the percentage of fat as the age increases is to be noted. This is contrary to what was found to exist for the other breeds. For Table XX, constructed from Tables XVI to XIX, a correlation of -0.138 ± 0.020 is found. This is practically the same correlation found for the Holstein-Friesian cows. This negative correlation resulting from combining the subgroups of Ayrshires is to be expected, since there is an increase in the milk yield with age and a decrease in the percentage of fat. (See Table E.) It may be that the requirements for entry in the register of the Ayrshire Association tend to eliminate high-yielding cows with a low percentage of fat and low-yielding cows with a high percentage of fat.

The correlation between the yield and percentage of fat for 98 Ayrshire cows which were tested and failed to meet the requirements was found to be

$$r = -0.226 \pm 0.065.$$

A larger number of such tests would be necessary to determine whether a difference exists between cows which meet the requirements and those which do not.

The percentage of butter fat among these 98 tests decreases with age as in Table E, as follows:

Number of animals.	Age.	Percentage of fat.
	<i>Years.</i>	
19	2 to 3.....	4.112
22	3 to 4.....	4.035
20	4 to 5.....	3.997
37	5 and over...	3.842

The work of Speir¹ shows that there is a slight tendency for the percentage of fat to decrease in Ayrshires after the third year. Both Jerseys and Guernseys of 5 years of age and over show a slight decrease. (See Tables A and B.) The mature class of Holstein-Friesian cows, however, does not show a decrease (Table C).

COWS NOT PURE-BRED

The writer thought it would be of interest to see the extent of correlation between the yield and percentage of fat in cows not pure-bred. Grade Jerseys, grade Holsteins-Friesians, and cows unclassified as to breed are considered.

Tables F, G, and H give the results of the study for the different classes in the order given above.

TABLE F.—Summary of results from a study of the correlation between the percentage of fat and yield of milk for grade Jerseys

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	101....	Milk.....	4,663.5 ± 81.7	1,217.0 ± 57.8	26.10 ± 1.32	} -0.114 ± 0.066
		Fat.....	5.106 ± 0.033	0.489 ± 0.023	9.57 ± 0.45	
3 to 4.....	155....	Milk.....	5,035.5 ± 71.3	1,316.0 ± 50.4	26.13 ± 1.07	} -0.234 ± 0.051
		Fat.....	5.124 ± 0.023	0.592 ± 0.023	11.56 ± 0.45	
4 to 5.....	146....	Milk.....	5,298.0 ± 71.5	1,281.5 ± 50.6	24.19 ± 1.01	} -0.272 ± 0.052
		Fat.....	5.068 ± 0.029	0.520 ± 0.021	10.26 ± 0.41	
5 and over....	348....	Milk.....	5,504.5 ± 48.1	1,329.0 ± 34.0	24.14 ± 0.65	} -0.138 ± 0.035
		Fat.....	4.923 ± 0.022	0.606 ± 0.016	12.32 ± 0.32	

¹ SPEIR, John. MILK RECORDS. In Trans. Highland and Agr. Soc. Scotland, s. 5, v. 16, p. 170-229, fig. 18-20. 1904.

TABLE G.—Summary of results from a study of the correlation between the percentage of fat and yield of milk for grade Holstein-Friesians

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
<i>Years.</i>						
2 to 3.....	76.....	Milk..... Fat.....	5,776.5 ± 113.4 3,638 ± 0.028	1,465.5 ± 80.2 0.361 ± 0.020	25.37 ± 1.48 9.80 ± 0.54	} -0.211 ± 0.074
3 to 4.....	83.....	Milk..... Fat.....	6,727.5 ± 112.1 3,563 ± 0.025	1,559.0 ± 79.3 0.344 ± 0.018	23.17 ± 1.24 9.64 ± 0.49	
4 to 5.....	41.....	Milk..... Fat.....	7,305.0 ± 214.8 3,581 ± 0.041	2,039.5 ± 151.9 0.391 ± 0.029	27.92 ± 2.23 10.92 ± 0.82	} -0.155 ± 0.103
5 and over....	136.....	Milk..... Fat.....	7,441.0 ± 104.1 3,546 ± 0.025	1,799.0 ± 73.6 0.440 ± 0.018	24.18 ± 1.05 12.39 ± 0.51	

TABLE H.—Summary of results from a study of the correlation between the percentage of fat and yield of milk for cows unclassified as to breed

[Fat in percentage; milk in pounds]

Age.	Number of animals.	Type of test.	Mean.	Standard deviation.	Coefficient of variability.	Correlation.
All ages.....	2,002..	Milk..... Fat.....	5,824.6 ± 28.5 3,902 ± 0.009	1,883.2 ± 20.1 0.575 ± 0.006	32.42 ± 0.38 14.75 ± 0.16	} -0.359 ± 0.013

There is a very significant negative correlation between the yield and percentage of fat for all three classes of cows represented by the three foregoing tables (Tables F-H).

CONCLUSIONS

(1) A significant negative correlation exists between the percentage of fat in cows' milk and the yield for the Jerseys, Guernseys, Holstein-Friesians, grade Jerseys, grade Holstein-Friesians, and cows unclassified as to breed. The correlation for Ayrshires is not significant in the subgroups classed in respect to age, but it is significant when these groups are treated as a whole. (See Tables XXI and F, G, H.)

(2) The yield of milk increases with age. However, since all cows 5 years of age and over are classed together, it may well be that the yield decreases at some period beyond 5 years. Pearl and Patterson¹ showed that in Jersey cows using the 7-day records that the maximum production is reached between the eighth and ninth year. Crowther² from records of Ayrshires is of the opinion that maximum production is close to the eighth year. (See Table XXI and fig. 1.)

(3) In the Jerseys, Guernseys, and Holstein-Friesians the percentage of fat remains fairly constant for the different ages studied. However,

¹ PEARL, Raymond, and PATTERSON, S. W. THE CHANGE OF MILK FLOW WITH AGE, AS DETERMINED FROM THE SEVEN-DAY RECORDS OF JERSEY COWS. *Maine Agr. Exp. Sta. Bul.* 262, p. 145-152, fig. 7. 1917.

² CROWTHER, Charles. VARIATION IN THE COMPOSITION OF COW'S MILK. *In Jour. Agr. Sci.*, v. 1, pt. 2, p. 149-175. 1905.

the group 5 years of age and over in the Jerseys and Guernseys shows a slightly lower percentage of fat than the younger groups. In the case of the Ayrshires, there is a gradual decrease with age. Between the youngest and oldest groups there is a difference of 0.151 per cent. (See Table XXI and fig. 2.)

(4) When judged by the standard deviation, age has no influence on the variability of the percentage of butter fat. But the class 5 years of age and over is more variable in the yield of milk than the younger groups. This may occur because of the inclusion in this group of old cows whose milk yield has decreased. (See Table XXI.)

(5) The breed has an influence on the variability of milk yield and percentage of fat, using the standard deviation as a basis of comparison. For variability in yield the breeds stand in the following order in an ascending scale: Jersey, Ayrshire, and Guernsey practically the same, Holstein-Friesian. For percentage of fat, the order is: Holstein-Friesian and Ayrshire about the same, Guernsey, Jersey. (See Table XXI.)

(6) For the production of milk the breeds stand as follows (see Table XXI.)

	Pounds.
Holstein-Friesian.....	14, 443. 1
Ayrshire.....	9, 417. 1
Guernsey.....	8, 644. 4
Jersey.....	7, 491. 4

(7) The average percentages of fat for the different breeds are as follows (see Table XXI.)

	Pounds.
Jersey.....	5. 392
Guernsey.....	5. 033
Ayrshire.....	3. 933
Holstein-Friesian.....	3. 435

TABLE I.—Correlation between the percentage of fat in cow's milk and the yield—Registered Jerseys 2 to 3 years of age

Percentage of fat

	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	Total.
4,000.....																														10
4,500.....																														30
5,000.....																														98
5,500.....																														130
6,000.....																														155
6,500.....																														132
7,000.....																														182
7,500.....																														87
8,000.....																														51
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14,000.....																														1
Total...	2	4	16	19	20	26	41	38	47	59	69	67	68	64	47	45	59	48	32	31	22	14	16	7	8	2	4	0	2	877

 $r = -0.360 \pm 0.020$

Yield of milk, in pounds.

TABLE II.—Correlation between the percentage of fat in cow's milk and the yield—Registered Jerseys 3 to 4 years of age

Percentage of fat

	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	Total.	
4,500.....																																				11
5,000.....																																				20
5,500.....																																				47
6,000.....																																				69
6,500.....																																				75
7,000.....																																				61
7,500.....																																				35
8,000.....																																				27
8,500.....																																				15
9,000.....																																				8
9,500.....																																				5
10,000.....																																				4
10,500.....																																				5
11,000.....																																				0
11,500.....																																				1
12,000.....																																				1
12,500.....																																				1
13,000.....																																				1
Total....	1	1	3	4	5	9	14	12	17	21	24	22	34	33	24	32	25	21	22	22	18	14	10	5	6	1	1	1	6	0	0	2	0	1	411	

 $r = -0.437 \pm 0.027$

Yield of milk, in pounds

TABLE III.—Correlation between the percentage of fat in cow's milk and the yield—Registered Jerseys 4 to 5 years of age

Yield of milk, in pounds	Percentage of fat																				Total.					
	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	Total.
5,500.																										2
6,000.																										15
6,500.																										18
7,000.																										30
7,500.																										33
8,000.																										37
8,500.																										27
9,000.																										13
9,500.																										17
10,000.																										16
10,500.																										6
11,000.																										2
11,500.																										2
12,000.																										0
12,500.																										0
13,000.																										0
13,500.																										0
14,000.																										1
Total.....	3	5	6	3	8	12	21	9	16	16	13	16	14	12	12	11	9	3	13	4	5	1	5	1	1	219

$r = -0.359 \pm 0.040.$

TABLE IV.—Correlation between the percentage of fat in cow's milk and the yield—Registered Jerseys 5 years and over

Percentage of fat

	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	Total.
5,500.....																														3
6,000.....																														19
6,500.....																														66
7,000.....																														66
7,500.....																														103
8,000.....																														82
8,500.....																														76
9,000.....																														60
9,500.....																														42
10,000.....																														37
10,500.....																														20
11,000.....																														16
11,500.....																														9
12,000.....																														8
12,500.....																														5
13,000.....																														5
13,500.....																														2
14,000.....																														2
14,500.....																														1
15,000.....																														0
15,500.....																														0
16,000.....																														0
16,500.....																														1
Total.....	1	1	4	7	9	16	19	22	29	39	43	49	42	50	59	46	38	26	31	23	26	15	12	5	5	4	4	2	2	634

$$r = -0.397 \pm 0.023$$

Yield of milk, in pounds

TABLE V.—Correlation between the percentage of fat in cow's milk and the yield—Registered Jerseys, all ages

[illegible]
$$r = -0.354 \pm 0.013.$$

TABLE VI.—Correlation between the percentage of fat in cow's milk and the yield—Registered Guernseys 2 to 3 years of age

		Percentage of fat																				Total.											
		3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6		5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7
Yield of milk, in pounds		4,500.																															
		5,000.																															
		5,500.																															
		6,000.																															
		7,000.																															
		7,500.																															
		8,000.																															
		8,500.																															
		9,000.																															
		9,500.																															
		10,000.																															
		10,500.																															
		11,000.																															
		11,500.																															
		12,000.																															
		12,500.																															
		13,000.																															
		13,500.																															
		14,000.																															
		14,500.																															
		15,000.																															
		Total.....	1	1	0	3	16	24	38	38	58	78	96	102	107	110	124	113	96	99	85	56	38	29	20	14	7	11	3	2	3	2	1

 $r = -0.251 \pm 0.017$

Yield of milk, in pounds

TABLE VII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Guernseys 3 to 4 years of age

Percentage of fat

	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	Total.
5,000.																																2
5,500.																																17
6,000.																																56
6,500.																																78
7,000.																																70
7,500.																																83
8,000.																																74
8,500.																																60
9,000.																																44
9,500.																																67
10,000.																																21
10,500.																																19
11,000.																																12
11,500.																																9
12,000.																																10
12,500.																																1
13,000.																																1
13,500.																																1
14,000.																																1
14,500.																																1
15,000.																																4
15,500.																																2
16,000.																																2
16,500.																																0
17,000.																																0
17,500.																																0
18,000.																																0
18,500.																																0
Total..	I	I	3	6	9	16	16	32	32	41	45	53	59	61	49	48	31	36	25	20	11	10	15	5	2	5	2	2	1	0	I	644

 $r = -0.289 \pm 0.024$

Yield of milk, in pounds

TABLE VIII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Guernseys 4 to 5 years of age

Percentage of fat

	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	Total.
5,500.....																																	2
6,000.....																																	6
6,500.....																																	19
7,000.....																																	41
7,500.....																																	45
8,000.....																																	47
8,500.....																																	70
9,000.....																																	59
9,500.....																																	42
10,000.....																																	20
10,500.....																																	26
11,000.....																																	25
11,500.....																																	22
12,000.....																																	15
12,500.....																																	9
13,000.....																																	4
13,500.....																																	10
14,000.....																																	2
14,500.....																																	3
15,000.....																																	6
15,500.....																																	1
16,000.....																																	2
16,500.....																																	0
17,000.....																																	0
17,500.....																																	1
Total....	1	1	2	3	10	16	15	26	30	35	27	35	41	26	41	37	36	34	21	13	12	7	4	2	1	0	1	0	0	0	0	1	478

 $r = -0.261 \pm 0.029$

Yield of milk, in pounds

TABLE IX.—Correlation between the percentage of fat in cow's milk and the yield—Registered Guernseys 5 years and over

[illegible]
$$\mu = -0.337 \pm 0.018.$$

TABLE X.—Correlation between the percentage of fat in cow's milk and the yield—Registered Guernseys, all ages

Percentage of fat

	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	Total.
4,500.....														2	1	5	6	1	7	6	1	1	1	1	1	1	1	1	1	1	1	1	3	
5,500.....											4	2	6	7	8	4	8	13	7	5	5	5	8	12	4	3	3	3	3	3	3	3	36	
6,000.....											8	13	17	13	27	20	16	21	20	12	10	16	11	6	3	2	2	2	2	2	2	2	103	
6,500.....											10	13	30	26	33	28	23	14	20	13	16	11	5	1	4	1	1	1	1	1	1	1	210	
7,000.....											13	17	32	31	39	35	19	29	23	24	11	11	5	1	4	1	2	2	2	2	2	2	281	
7,500.....											14	32	41	43	43	32	30	24	29	15	11	5	7	2	8	2	5	1	1	1	1	1	338	
8,000.....											21	39	45	48	45	30	20	20	19	15	11	8	4	4	2	2	2	2	2	2	2	2	373	
8,500.....											27	46	51	54	51	34	26	29	20	19	13	10	4	4	1	2	1	1	1	1	1	1	370	
9,000.....											31	51	57	60	57	40	33	30	22	19	13	10	4	4	1	2	1	1	1	1	1	1	362	
9,500.....											33	53	60	62	59	42	35	28	22	19	12	8	1	2	1	1	1	1	1	1	1	1	317	
10,000.....											35	55	63	64	61	44	37	30	24	20	14	9	6	1	2	1	1	1	1	1	1	1	279	
10,500.....											37	56	65	66	63	46	39	32	26	21	16	10	7	1	2	1	1	1	1	1	1	1	188	
11,000.....											39	58	67	68	65	48	41	34	28	23	17	11	8	1	2	1	1	1	1	1	1	1	147	
11,500.....											41	59	69	70	67	50	43	36	30	25	19	13	9	1	2	1	1	1	1	1	1	1	93	
12,000.....											43	60	71	72	69	52	45	38	32	27	21	15	10	1	2	1	1	1	1	1	1	1	76	
12,500.....											45	62	73	74	71	54	47	40	34	29	23	17	11	1	2	1	1	1	1	1	1	1	61	
13,000.....											47	64	75	76	73	56	49	42	36	31	25	19	13	1	2	1	1	1	1	1	1	1	32	
13,500.....											49	66	77	78	75	58	51	44	38	33	27	21	15	1	2	1	1	1	1	1	1	1	31	
14,000.....											51	68	79	80	77	60	53	46	40	35	29	23	17	1	2	1	1	1	1	1	1	1	15	
14,500.....											53	70	81	82	79	62	55	48	42	37	31	25	19	1	2	1	1	1	1	1	1	1	25	
15,000.....											55	72	83	84	81	64	57	50	44	39	33	27	21	1	2	1	1	1	1	1	1	1	10	
15,500.....											57	74	85	86	83	66	59	52	46	41	35	29	23	1	2	1	1	1	1	1	1	1	4	
16,000.....											59	76	87	88	85	68	61	54	48	43	37	31	25	1	2	1	1	1	1	1	1	1	1	4
16,500.....											61	78	89	90	87	70	63	56	50	45	39	33	27	1	2	1	1	1	1	1	1	1	2	
17,000.....											63	80	91	92	89	72	65	58	52	47	41	35	29	1	2	1	1	1	1	1	1	1	1	2
17,500.....											65	82	93	94	91	74	67	60	54	49	43	37	31	1	2	1	1	1	1	1	1	1	1	2
18,000.....											67	84	95	96	93	76	69	62	56	51	45	39	33	1	2	1	1	1	1	1	1	1	1	2
18,500.....											69	86	97	98	95	78	71	64	58	53	47	41	35	1	2	1	1	1	1	1	1	1	1	2
19,000.....											71	88	99	100	97	80	73	66	60	55	49	43	37	1	2	1	1	1	1	1	1	1	1	1
19,500.....											73	90	101	102	99	82	75	68	62	57	51	45	39	1	2	1	1	1	1	1	1	1	1	1
Total.....	4	4	8	16	41	63	111	122	187	211	246	275	275	294	305	273	241	216	204	135	87	76	52	42	21	20	10	7	3	1	1	1	1	3,564

 $r = -0.296 \pm 0.010$

Yield of milk, in pounds

TABLE XI.—Correlation between the percentage of fat in cow's milk and the yield—Registered Holstein-Friesians 2 to 3 years of age

		Percentage of fat																			Total.
		2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	
Yield of milk, in pounds	6,000																I				I
	6,500															I					I
	7,000											I	I	2							4
	7,500										2	3	2		2		2			I	12
	8,000							I		3	2	4	I	2							13
	8,500							4	4	5	I	5	2	3	3	I					28
	9,000				I	I	2	2	4	4	I	7	7	2	2						33
	9,500				2	I	3	I	2	5	3	4	2		I	I	I				26
	10,000					2	2	6	7	5	6	3	4	2				I			38
	10,500							5	4	3	2	4	3		2	3		I			28
	11,000					3	3	3	3	5	3	5	4	I	I	I					32
	11,500			I	I	4	3	7	6	5	I	5	5	2	2					I	53
	12,000				I	I	2	4	5	8	5	4	4	I	I		I				37
	12,500				I		5	3	5	6	3	5	2	3		I	2	I		I	38
	13,000						I	5	5	6	4	4	6		I						41
	13,500		I			4	3	I		7	6	3	4	2	I			I	I		30
	14,000						2	2	3	3	3	5	4	2				I	I	I	29
	14,500		I				3	6	3		2	4	I		I	2	I				24
	15,000					I	3	5	I	2	7	4	2		2				I		28
	15,500				I		2	4	8	7	2	3	I	I	I						30
16,000					I	2	2	4	I	2	I	I	I	I	I	2				19	
16,500							4	I	3	4	2	2				I		I		18	
17,000					I		I		I	I	2	2		I						9	
17,500						I	I	I			2	3								8	
18,000				I		I	I			2		I		I		I		I		10	
18,500					I				2				I							4	
19,000		I			I	I			I	I										5	
19,500										I	I		I		I					3	
20,000										I		I								2	
20,500											I									I	
21,000						I					I			I						3	
21,500																				0	
22,000													I							I	
22,500																				0	
23,000						I														I	
Total..		I	2	3	14	24	42	63	68	85	77	83	62	30	25	9	10	7	2	3	610

$r = -0.116 \pm 0.027.$

TABLE XII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Holstein-Friesians 3 to 4 years of age

	Percentage of fat																	Total.
	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	
Yield of milk in pounds																		
8,000.....												I	I					2
8,500.....										I	I		I					3
9,000.....							I	I	I	2	2	I	4					12
9,500.....							2	I	I	2	I			I	2			12
10,000.....							I		2	3	4	I	I					12
10,500.....						I	2		2		6	2	3					16
11,000.....		I				I	4	3			I	I	3	2				16
11,500.....				I	I	2	2	2	4	I	I	I	2	I				18
12,000.....			I	I	I	2	I	2	4	2		2	I	I				18
12,500.....					I		I	4	4	I	2	2			I		I	18
13,000.....			I	I	I	2	I	I	5	2	I	2	I	I	I			20
13,500.....	I			2	I	4	5	3	3	3	7	2	3	I	I			36
14,000.....		I	I	I		2	3	2	2	2		I	2			I		18
14,500.....	I				2		2	5	2	4	2	I	I	2				22
15,000.....			I			3		2	3	2	2		I					14
15,500.....					2	I		I	3		3			I	2	2		15
16,000.....				I	2	2	3		3	2	I					I		15
16,500.....					2	2		5	I		2	2						12
17,000.....					2	2	I			2			I					6
17,500.....				I	2			I	5		I		I	I		I		15
18,000.....							2	I		I	I							5
18,500.....				I	I		2	I	2				I					8
19,000.....				I				I	2	2	I						I	8
19,500.....							I	I	I	2								4
20,000.....			I		I			2										4
20,500.....				I														I
21,000.....									I		I							2
21,500.....						I				I								2
22,000.....																		0
22,500.....		I						I						I				3
23,000.....							I							I				2
23,500.....																		0
24,000.....					I													I
24,500.....																	I	I
Total ...	2	2	6	11	16	27	30	42	52	34	42	20	27	12	7	4	2	341

$$r = -0.160 \pm 0.036$$

TABLE XIII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Holstein-Friesians 4 to 5 years of age

Percentage of fat

Yield of milk in pounds																									Total.
	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6				
8,000.....															I								I		
8,500.....														I									2		
9,000.....															I	I							5		
9,500.....									I		I				2	I							3		
10,000.....														I		I							9		
10,500.....							2	I	2	I	2	I											14		
11,000.....					I	I	4	I	3	2	2				I								14		
11,500.....					I	I	4		I	5	I			I									19		
12,000.....						I	3	2		5	2	2	I		2		I						17		
12,500.....			I	3	3	I	2	3				2	I	I									13		
13,000.....			I		I	I	I	I	4	3	I		I										21		
13,500.....			I	I	2	3	2	5	2	3			I	I									20		
14,000.....			I	I	I	I	3	5	I	5	2												16		
15,000.....					I	2		I		6			2	2		2							16		
15,000.....					I	I	3	2	2		I	3	I	2									16		
15,500.....	I	I			I	I	2	3	I	I	3		I	I									16		
16,000.....					3		3	3		4	2												15		
16,500.....					I		4	I				2			I	I							10		
17,000.....			I			I	3	5	2	3	I	4		I									21		
17,500.....			I	I	2	I		I	2	I	I		I						I				12		
18,000.....				I	I					I													4		
18,500.....			2				I		2		2	I		I									10		
19,000.....	I				I			2	2														5		
19,500.....										I	2												6		
20,000.....												I	I										5		
20,500.....											I					2							5		
21,000.....										I									I		I		1		
21,500.....					I																	2			
22,000.....							I	I		I	I				I							3			
22,500.....																						2			
23,000.....																						0			
23,500.....																						0			
24,000.....		I		I				I		I												4			
Totals..	2	2	I	II	19	19	37	33	39	39	30	20	12	12	10	3	0	0	2	0	I		292		

$$r = -0.088 \pm 0.039$$

TABLE XIV.—Correlation between the percentage of fat in cow's milk and the yield—Registered Holstein-Friesians 5 years and over

Yield of milk, in pounds	Percentage of fat																				Total.				
	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5		4.6	4.7	4.8	4.9
9,000.															I									I	2
9,500.											I			I		I									3
10,000.											I			I											2
10,500.											I			I											5
11,000.									I	4	3	I	2	3	I		I								16
11,500.						I	5	2	3	6	I	2				I									21
12,000.						I	2	6	4	I	3			I											13
12,500.					4	6	7	4	4	9	4	4	4			2									48
13,000.					5	6	3	8	6	6	3	I			I		2								41
13,500.		I		I	I	3	4	3	7	3	I	5	I			I									31
14,000.				I	2	I	2	6	6	4	4	7	I	I			I	I	I						38
14,500.					I		3	6	3	7	5	4	2	I		I									36
15,000.				I	5	I	I	8	5	2	7		3	4	3			I							41
15,500.				I	2	I	5	3	4	6	4	3	I	I											32
16,000.				I	I	3	5	12	3	2	2	4	2		I				I						37
16,500.				I	2	8	2	5	7		4	2		3			I								35
17,000.	I			2	2	5	2	6	9	2	4	I	2	I											37
17,500.			I		2	I	5	7	5	4	6	I	2	2		I									37
18,000.					2	5	5	2	2	I	I	5			I			2							27
18,500.			I		I	I	4	5	4	4	8					I									29
19,000.						5		3	5	4	I														18
19,500.						2	4	2	5	4	3			I		I									22
20,000.				I		I	I	4	3	5	I														16
20,500.				I		4	I	I		3	I			2											17
21,000.					I	I		I		I								I		I					6
21,500.					I	I	2		4	2		I		I											13
22,000.				I			2	I	3		3			I	I										12
22,500.						2	2	2	I		I														8
23,000.								I	I		2			I											5
23,500.						I		I					I												3
24,000.																									I
24,500.								I					I												2
25,000.					I	I								2											4
25,500.								I			I			I	I										4
26,000.				I	I				3																5
26,500.																									0
27,000.				I																					I
27,500.														I											I
28,000.						I			I		I														3
28,500.																									0
29,000.						I				I															2
29,500.							2																		2
30,000.																									0
30,500.						I																			I
Total	I	I	7	14	35	64	74	101	99	93	61	51	23	27	8	9	4	5	I	2	I	0	0	I	682

$$r = -0.115 \pm 0.026$$

TABLE XV.—Correlation between the percentage of fat in cow's milk and the yield—Registered Holstein-Friesians, all ages

	Percentage of fat																													Total.
	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9						
Yield of milk, in pounds																														
6,000																													I	
6,500																													I	
7,000																													12	
7,500																													16	
8,000																													32	
8,500																													49	
9,000																													46	
9,500																													55	
10,000																													58	
10,500																													78	
11,000																													106	
11,500																													92	
12,000																													121	
12,500																													115	
13,000																													118	
13,500																													105	
14,000																													98	
14,500																													99	
15,000																													93	
15,500																													86	
16,000																													75	
16,500																													72	
17,000																													46	
17,500																													51	
18,000																													36	
18,500																													35	
19,000																													27	
19,500																													24	
20,000																													12	
20,500																													17	
21,000																													16	
21,500																													13	
22,000																													8	
22,500																													3	
23,000																													6	
23,500																													3	
24,000																													4	
24,500																													4	
25,000																													5	
25,500																													0	
26,000																													1	
26,500																													1	
27,000																													3	
27,500																													0	
28,000																													2	
28,500																													2	
29,000																													0	
29,500																													0	
30,000																													0	
30,500																													I	
Total..	6	7	17	50	94	152	204	244	275	243	216	153	92	76	34	26	13	9	7	4	2	0	0	I					1,925	

$$r = -0.133 \pm 0.015$$

TABLE XVI.—Correlation between the percentage of fat in cow's milk and the yield—Registered Ayrshires 2 to 3 years of age

Percentage of fat

	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	Total
Yield of milk, in pounds																											
5,500.....				2		2	3	1		1	6		1														3
6,000.....				1			5	5	3	4	5	3	4	1													15
6,500.....							12	5	4	14	7	6	3	2		1											34
7,000.....				1		5	4	3	12	8	9	2	6	1	1												70
7,500.....						2	4	3	7	8	5	3	6	3													54
8,000.....				1		1	4	4	4	5	3	3	3	6													49
8,500.....						2	1	6	2	5	3	1	2	3	1												34
9,000.....				1		1	3	4	5	2	1	1	1														24
9,500.....						2	2	4	2	3	2	2															20
10,000.....				1		2	3	3	3	1	2	1	1														21
10,500.....				1			1	2	1	1	1	1	1	1													7
11,000.....							1					1	1	1													8
11,500.....									1		1																0
12,000.....										1																	2
12,500.....										1																	1
13,000.....											1																1
Total.....	1	1	5	20	14	23	43	34	40	50	44	21	25	11	3	4	3	0	0	0	0	0	0	0	0	1	343

 $r = +0.019 \pm 0.036.$

TABLE XVII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Ayrshires 3 to 4 years of age

		Percentage of fat																		Total.	
		3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	
Yield of milk, in pounds	6,500.....									1	1	1	1			1					5
	7,000.....				1			2	1	1	1	1				3					10
	7,500.....							3	2	1	3	5	6	1	2		1				24
	8,000.....						1	3	3	4	2	5	2	2			1				23
	8,500.....					3	1		4	4	3	6	2	3	5	2	2				35
	9,000.....					1	2	1	2	2			1	3	4	1	1	1	1		20
	9,500.....					2	1		1	3	3	3			1	1		1	1		17
	10,000.....					1	1		1	2	2	2	4	2	2	2				1	19
	10,500.....					1	1		3	1		1	1	1	1	1					11
	11,000.....					1				2		2		1				1			7
	11,500.....							1					1		1						3
	12,000.....		1									1					1				3
	12,500.....					1					1				1						3
	13,000.....						1				1	1				1					4
	13,500.....						1														1
14,000.....											1		1		1					3	
14,500.....									1							1				2	
15,000.....							1				1									2	
Total.....		1	0	0	4	10	7	14	18	20	22	28	19	17	16	6	7	1	1	1	192

$$r = -0.093 \pm 0.048$$

TABLE XVIII.—Correlation between the percentage of fat in cow's milk and the yield—Registered Ayrshires 4 to 5 years of age

		Percentage of fat																		Total.
		3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	Total.	
Yield of milk, in pounds	7,500.....								2					1					3	
	8,000.....				1			2	3	6	1	3	4	3	3	1			27	
	8,500.....				1	1	4	2	2	3	3	1	3				1		21	
	9,000.....				2		1	4	5	1	5	3	2	1	1	2	2		29	
	9,500.....				4	1	3	3	4	4	3	4	1						27	
	10,000.....							2	2	1	3		2				1	1	12	
	10,500.....	1		1	1	4	3		1	1	2	1	1	1					16	
	11,000.....							1			1	3	1						6	
	11,500.....						1	1	1	1		1							5	
	12,000.....												1	1	1				3	
	12,500.....										1		1						2	
	13,000.....					1	1			1				1					3	
	13,500.....					1		1											2	
	14,000.....									1		1							2	
	14,500.....																		0	
	15,000.....								1										1	
	15,500.....																		0	
	16,000.....																		0	
16,500.....																		0		
17,000.....																		0		
17,500.....																	1	1		
Total.....		1	0	1	9	7	13	16	21	19	19	18	16	7	4	5	3	1	160	

$$r = -0.023 \pm 0.053$$

TABLE XIX.—Correlation between the percentage of fat in cow's milk and the yield—
Registered Ayrshires 5 years and over.

		Percentage of fat																			Total.
		3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	
8,500.								2	8	4	4	5			1					1	25
9,000.				1	1			7	9	10	3	3	5		5	2			1		62
9,500.					3	5	6	9	5	9	10	4	3	5	1						57
10,000.				1	6	3	3	2	10	10	5	1	1	5	1				1		50
10,500.			1	1	5	2	1	9	7	3	6	5	2								42
11,000.			3	2	4	3	7	6	5	5	4	4	2	1					1		47
11,500.		1		1	2	2	4	2	4	3	2	1	4			1			1		38
12,000.					1	2	1	3	4	2	4	1	1			1		1			20
12,500.							3	3	5	3	3	1			1			1			20
13,000.				1	2	2		1	3		1	2			1	1					15
13,500.				1	1					1	2										5
14,000.							1	1				3			1						6
14,500.						1	1		1	1					1						5
15,000.															1	1					2
15,500.						1		1		1			1								4
16,000.																					0
16,500.								1													0
17,000.						1						1									2
17,500.																					0
18,000.																1					0
18,500.																					0
19,000.																					0
19,500.																					0
20,000.									1												0
20,500.																					0
21,000.									1												0
21,500.																					0
22,000.											1										0
22,500.																					0
23,000.											1										1
Total.....		1	4	8	25	22	34	49	65	46	45	30	19	21	11	5	3	4	2	2	396

$$r = -0.047 \pm 0.034$$

TABLE XX.—Correlation between the percentage of fat in cow's milk and the yield—Registered Ayrshires, all ages

Yield of milk, in pounds	Percentage of fat																				Total.										
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	Total.		
5,500.....						2	2	2	3	I		I	6																	3	
6,000.....						I	2	6	13	6	4	5	5	3	5	I															15
6,500.....						I	5	7	5	6	17	14	10	5	3	2	I														39
7,000.....						I	I	5	6	6	17	14	10	5	3	2	I														80
7,500.....						I	2	7	5	6	I	13	11	6	9	5															99
8,000.....							5	4	5	9	20	14	15	13	9	6	I														115
8,500.....						I	I	4	3	11	18	23	5	21	11	8	5	3													135
9,000.....							9	8	9	15	14	20	12	10	8	9	I	2													121
9,500.....							8	4	5	16	16	15	6	7	8	2	I	2													102
10,000.....							7	7	10	8	6	10	8	5	2																76
10,500.....						I	3	8	7	7	5	9	5	8	4	2	I														68
11,000.....							3	2	5	3	5	4	3	2	5	I	I														26
11,500.....						I	I	2	2	6	3	5	2	2	I	I															28
12,000.....							I	2	2	I	2	4	2	2	I	I															36
12,500.....							I	3	3	3	3	4	2	2	2	I															23
13,000.....							I	2	I	2	I	2	2	2	I																8
13,500.....							I	I	I	I	2		5		2																11
14,000.....							I	I	I	I	I				I	I															7
14,500.....							I	I	I	I	I				I	I															5
15,000.....							I	I	I	I	I				I	I															4
15,500.....								I																							0
16,000.....																															0
16,500.....																															0
17,000.....																															0
17,500.....												I																			0
18,000.....																															0
18,500.....																															0
19,000.....																															0
19,500.....																															0
20,000.....																															0
20,500.....																															0
21,000.....																															0
21,500.....																															0
22,000.....																															0
22,500.....																															0
23,000.....																															0
Total.....	I	2	5	14	49	56	75	106	149	121	132	117	96	65	46	28	10	10	6	2	0	0	0	0	0	0	0	0	I	1,091	

 $r = -0.138 \pm 0.020$

TABLE XXI.—Summary of results from a study of the correlation between percentage of fat and milk yield among different breeds of dairy cows

Breed and age.	Number of animals.	Milk.			Fat.			Correlation between percentages of fat and yield of milk.
		Mean.	Standard deviation.	Coefficient of variability.	Mean.	Standard deviation.	Coefficient of variability.	
Jersey, 2 to 3 years.	877	6,475.0 ± 28.9	1,270.5 ± 30.5	19.62 ± 0.33	5,425 ± 0.012	0.517 ± 0.008	9.52 ± 0.15	-0.360 ± 0.020
Jersey, 3 to 4 years.	411	7,325.0 ± 45.8	1,377.5 ± 32.4	18.81 ± .46	5,401 ± .019	.509 ± .013	10.41 ± .25	-.437 ± .027
Jersey, 4 to 5 years.	219	8,043.4 ± 60.7	1,312.5 ± 42.9	16.57 ± .55	5,462 ± .024	.533 ± .017	9.76 ± .32	-.350 ± .040
Jersey, 5 years and over.	634	8,814.5 ± 43.1	1,668.5 ± 30.5	18.25 ± .35	5,392 ± .013	.503 ± .010	9.44 ± .18	-.397 ± .023
Jersey, all ages.	2,141	7,491.4 ± 25.0	1,718.0 ± 17.7	22.03 ± .25	5,392 ± .008	.525 ± .005	9.74 ± .10	-.354 ± .013
Guernsey, 2 to 3 years.	1,375	7,668.0 ± 28.8	1,584.0 ± 30.4	20.82 ± .77	5,065 ± .008	.458 ± .006	9.01 ± .32	-.251 ± .017
Guernsey, 3 to 4 years.	644	8,317.0 ± 49.3	1,854.0 ± 34.8	22.29 ± .44	5,080 ± .013	.477 ± .009	9.30 ± .18	-.289 ± .024
Guernsey, 4 to 5 years.	418	9,247.0 ± 62.6	2,030.0 ± 44.3	21.91 ± .50	5,046 ± .014	.460 ± .010	9.13 ± .20	-.264 ± .029
Guernsey, 5 years and over.	1,067	9,893.0 ± 42.8	2,067.5 ± 30.2	20.99 ± .68	4,956 ± .010	.478 ± .007	9.64 ± .30	-.337 ± .018
Guernsey, all ages.	3,564	8,644.4 ± 23.7	2,095.4 ± 16.7	24.24 ± .20	5,033 ± .005	.471 ± .004	9.35 ± .08	-.296 ± .010
Holstein-Friesian, 2 to 3 years.	610	12,488.5 ± 80.4	2,942.0 ± 56.8	23.56 ± .48	3,462 ± .008	.394 ± .006	8.50 ± .16	-.116 ± .027
Holstein-Friesian, 3 to 4 years.	341	13,938.5 ± 116.5	3,188.0 ± 82.4	22.87 ± .62	3,433 ± .012	.322 ± .008	9.38 ± .24	-.160 ± .036
Holstein-Friesian, 4 to 5 years.	292	14,825.5 ± 124.3	3,151.0 ± 87.9	21.25 ± .62	3,417 ± .012	.311 ± .009	9.17 ± .26	-.088 ± .039
Holstein-Friesian, 5 years and over.	682	16,280.0 ± 94.4	3,654.5 ± 66.7	22.43 ± .43	3,430 ± .008	.301 ± .006	8.81 ± .16	-.115 ± .026
Holstein-Friesian, all ages.	1,925	14,443.1 ± 56.0	3,640.7 ± 39.6	25.21 ± .29	3,435 ± .005	.305 ± .003	8.88 ± .10	-.133 ± .015
Ayrshire, 2 to 3 years.	343	7,966.5 ± 47.9	1,314.5 ± 31.9	16.51 ± .44	4,016 ± .011	.310 ± .008	7.71 ± .20	+ .010 ± .036
Ayrshire, 3 to 4 years.	162	9,179.5 ± 86.1	1,769.5 ± 60.9	19.28 ± .69	3,936 ± .014	.314 ± .011	6.15 ± .28	-.093 ± .048
Ayrshire, 4 to 5 years.	160	9,584.5 ± 83.5	1,566.5 ± 59.1	16.34 ± .63	3,919 ± .016	.303 ± .011	7.73 ± .20	-.023 ± .043
Ayrshire, 5 years and over.	396	10,726.0 ± 67.1	1,980.0 ± 47.5	18.46 ± .46	3,865 ± .011	.313 ± .008	8.10 ± .19	-.047 ± .034
Ayrshire, all ages.	1,091	9,417.1 ± 41.7	2,044.4 ± 29.5	21.71 ± .33	3,933 ± .006	.318 ± .005	8.08 ± .12	-.138 ± .020

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