EXPERIMENT STATION

OF THE

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ANIMAL-HUSBANDRY DEPARTMENT.

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Experiments with Dairy Cows.

OF the agricultural industries contributing to Kansas success, dairying is playing a very important part, and is destined to become still more important as land becomes more valuable and as population increases. This is especially true in the central and western parts of the state, where the income from crops is more or less uncertain.

At times the dairy industry of the state has received a setback, because of too much enthusiasm from the possibilities of getting rich quickly. New creameries and skimming stations have been started, and every one who had a cow, no matter what her capacity, was induced to milk her and send the milk to the skimming station. For a time the creamery or station would appear prosperous; but on account of milking cows that were not profitable, it was not long until the interest began to fail, and the farmers would say that it did not pay to milk cows. Doubtless it did not pay to milk the class of cows that some farmers owned, and on account of these experiences with unprofitable cows it has been very difficult to get these men to engage in dairying with profitable cows.

*The dairy work of the College and Station, which contributed the material for this bulletin, was first in charge of Prof. H. M. Cottrell, to whom much credit is due for its successful inauguration and hearty support. The author is also indebted to the following graduates of the College who have acted as herdsmen, and lent their hearty cooperation in carrying out the details of the dairy work: J. A. Conover, H. M. Bainer, E. B. Patten, F. E. Uhl, and George C. Wheeler. During the past year, Mr. Wheeler has been acting assistant in the animal-husbandry department.

For continued success of the dairy industry it is not wise to laud its possibilities to the skies, but more effort should be spent in demonstrating what kind of cows it will pay to milk, Work of this kind will result in much more permanent good than injudicious exhortation to go into the business regardless of the class of cows milked. There are just as many business principles involved in successful dairying as there are in successful merchandising, and the dairy industry, in order to obtain permanent success, must be based upon certain underlying business principles.

The Kansas Experiment Station has been working with common grade and pure-bred cows, with a view of trying to solve some of the principal problems that assail our Kansas dairymen, and in this bulletin are detailed our experiences, together with comparisons that are drawn from outside sources.

WHAT THE AVERAGE KANSAS COW IS DOING.

From the statistics gathered by the Kansas State Board of Agriculture, we have sized up the average Kansas cow as to what she is doing in butter-production and in cash income. In constructing the following table, the value of the butter produced was divided by the number of pounds produced, which gave the average price per pound. Assuming that the milk used in cheese-making and what was sold was on the same basis, we divided the total value of these products by the average price per pound, which gives the total pounds of butter produced; dividing this by the number of milch cows in the state, we have the number of pounds of butter produced by each cow. By adding the total values together and dividing by the number of cows, we have the cash income per cow.

TABLE I.—Showing what the average Kansas cow is producing.

YEAR.	Number of milch cows.	Income per cow.	
		Butter.	Cash.
1893	567,353	53 lbs.	$8 54
1894	524,127	52 "	9 29
1895	517,254	67 "	8 72
1896	515,075	79 "	9 58
1897	552,538	77 "	9 51
1898	605,925	77 "	9 98
1899	684,182	71 "	9 54
1900	712,582	65 "	10 46
1901	793,389	55 "	9 74
1902	791,844	62 "	10 79
Averages.	626,426.9	65.8 lbs.	$9 615

In figuring table I, the average seemed to be so very low that the figures were checked over several times. Of course, it is possible that the assessors do not get account of all the cows and perhaps do not get account of the full production of all the cows; but even allowing

a good margin for any discrepancy of this kind, the average production of the Kansas cow is shamefully low. Even at the high average, twenty cents per pound for butter, the average Kansas cow is hardly producing enough to pay for the expense of milking, to say nothing of the cost of feed, interest on the money invested, etc. The cash income is also remarkably low; and unless a man can realize more than is shown in these figures he cannot expect to make a profit out of dairying.

CREAMERY PATRON'S INVESTIGATIONS.

In order to inquire more fully into the results that are being obtained from Kansas dairy cows, the Kansas Experiment Station inaugurated an investigation during the summer of 1898. The Meriden Creamery Company kindly lent every assistance possible to carry out this investigation and in getting data throughout Jefferson county. An attempt was made to secure this information through the medium of letters containing an outline of the information wanted. Of the 300 letters sent to patrons, only eight replies were received. It became evident that in order to get this information personal interviews must be made with the individual patrons. Not all of these seen were able to give any idea as to the results they had obtained with their cows. One man said if he could answer the list of questions sent him that he would run for Congress. Through the kindness of the creamery management, who furnished a man and rig to drive to the patrons homes, we were able to collect records and notes from eighty-two different patrons. Tables II and III give a summary of the results obtained.

TABLE II.—A year's record of best five herds.

NUMBER OF COWS KEPT.	Milk produced per cow.	Butter per cow.	Income from milk per cow.	Total income per cow.
20	5,546 lbs.	317 lbs.	$42 09	$54 38
3	6,371 "	243 "	34 29	45 87
9	5,159 "	244 "	31 46	45 14
4	5,229 "	236 "	30 87	40 33
6	5,075 "	226 "	30 00	39 95
Averages	5,476 lbs.	253 lbs.	$33 74	$45 13
Av. of 82 patrons	3,441 lbs.	123 lbs.	$19 79	$32 86

TABLE III.—A year's record of poorest five herds.

NUMBER OF COWS KEPT.	Milk produced per cow.	Butter per cow.	Income from milk per cow.	Total income per cow.
27	1,117 lbs.	57 lbs.	$7 54	$20 69
12	1,486 "	67 "	8 04	18 04
10	1,678 "	70 "	8 84	23 42
3	1,901 "	84 "	10 70	19 12
8	2,057 "	91 "	12 08	36 71
Averages	1,644 lbs.	74 lbs.	$9 44	$23 59

YIELD OF MILK. In the yield of milk, the herds varied all the way from 1117 pounds to 6371 pounds, a difference of 5254 pounds of milk, or 470 per cent. Examining the two tables, it will be noticed that the average yield per cow of the best five herds was 5476 pounds, and of the poorest five herds 1644, a difference of 3832 pounds per cow, or 233 per cent.

YIELD OF BUTTER-FAT. It is interesting to see that there is a very great variation. The annual average of eighty-two patrons is 104.5 pounds of butter-fat. Figuring this butter-fat to butter (which is 85 per cent. butter-fat) we have the average yield of butter per cow as 123 pounds. This is nearly, though not quite, twice as much as given in table II. It should be borne in mind, however, that at the time of this investigation Jefferson county was one of the very best dairy districts in the state. Comparing the butter-fat yield in the two tables, we see that the last yield is from a herd of twenty-seven cows, which made an average of 48.5 pounds per cow, and the highest is from a herd of twenty cows, which averaged 269.5 pounds per cow. The difference between the average of the poorest and the best herd is 221 pounds of butter-fat per year, or an increase of the best herd over the poorest herd of 456 per cent. An average of the best five herds is 215.05, and of the poorest five herds is 63 pounds, a difference of 152.05 pounds, or 241 per cent.

Enterprising dairymen claim that it will take 150 pounds of butter-fat a year per cow to pay for keeping her, and the profit comes from the yield given above that amount. If this be true, the cows that belong to the poorest dairy herds are, so far as milk- and butter-fat production are concerned, running their owners in debt, and were it not for the reedeming features of the calves produced, they would be better off without any cows.

CASH INCOME FOR BUTTER-FAT. The eighty-two herds averaged $19.79; the best herd averaged $42.09, and the poorest herd $7.54, a difference of $34.55 per cow; the difference between the average of the best five herds and the poorest five herds was $24.30 per cow. If this difference was figured on the basis of ten cows it would amount to $243 per year, or $2400 in ten years.

VALUE OR CALVES. An estimate of the value of calves at weaning time was obtained from each of the eighty-two patrons. This estimate varied from $4 to *$20* per head. The estimate of the value of the calves from the best five herds averaged $8 per head and from the poorest five herds $12 per head. From this it will be seen that the poorest herds had the best calves by $4 per head, to compensate for the great loss of milk and butter-fat.

Estimates were also obtained as to the value of the skim-milk. These estimates ranged all the way from the equivalent of so much dish-water to fifty cents per 100 pounds. Counting in the income from the butter-fat, to which we add the estimate of the patrons as to the value of the calf and the value of the skim-milk fed to pigs (the value of the skim-milk fed to calves being counted as part of the value of the calf), we have the total income per cow for each of these herds. The total annual income per cow of the eighty-two patrons was $32.86, for the best herd $54.38, and for the poorest herd $18.04-- a difference between the best and poorest of $36.34 per cow. The average for the best five herds is $45.13, and for the poorest five herds $23.59-- a difference of $21.54, or ninety-one per cent. One of the patrons that received the lowest income valued his calves at $20 per head.

The difference between these herds is more than really appears on the surface. To show this difference, we will assume that it costs the owners of the poorest five herds $15 per year to keep a cow. This amount will doubtless be greater with the owners of the best five herds, as they will furnish better care and probably better feed. We will add one-third more, or $20, as the cost of the keep of a cow of the best five herds. Subtracting $20 from the total income from the best herds, there remains a profit of $34.48 per cow. Subtracting $15 from the total income of the poorest herd, we have left $3.04 profit, or a difference in the profit of these two herds of $31.34 per cow. To put it in another light, this amounts to one cow in the best herd bringing as much clear cash to a man as eleven cows from the poorest herd, and only one cow to milk, shelter, and feed.

If we take the average of the best five herds in the same manner, we have a profit of $25.13; from the poorest five herds, a profit of $8.59--a difference of $16.54 per cow. In other words, one average cow from the best five herds brings a man as much clear cash as three average cows from the poorest five herds.

In the above comparisons only averages of the herds have been used. If it had been possible to have carried the investigation further, and found what each cow was doing in the herd, we would doubtless have found as much variation between individuals of the herds as between the herds.

WHY THE DIFFERENCE? Doubtless many conditions enter in to produce these differences, but back of them all is the one great difference, the *man.* A man's cows seldom exceed his ideas of what a cow should be. Out of seventy-nine patrons who expressed themselves on the subject, fifty-six were general-purpose men, thirteen beef men, and ten special dairymen. Three of the general-purpose men intimated that the dairy business was unprofitable unless there were children at

home to do the milking, and one man went *so* far as to say that he left his cows unmilked if the children happened to be away at milking time. Such men will not make a success of dairying no matter what their environments are.

Next to the man himself, the cow doubtless stands as the cause of this great variation. Too many cows are to-day debt contractors instead of debt lifters, and, unfortunately, too many of our dairymen are unable to distinguish between the two. They seem to think that because they get a little milk from a cow they are so much ahead; but they do not figure what it has cost to produce that milk. The importance of a good cow will be discussed a little later on.

The feed problem is another important factor in accounting for the difference in these herds. The grain ration fed to the best five herds contained bran, oats and oil-meal in addition to corn and roughness. The corn-fodder and prairie hay were balanced by alfalfa and Red clover. In the poorest five herds there was one man who fed no grain whatever, three fed ear corn alone, and only one herd was fortunate enough to have oats in connection with corn-meal. Stalk-fields, corn-fodder, prairie hay or millet constituted the roughness, only one herd being fed a little clover hay.

The kind of sires used by these men undoubtedly had much to do in regard to the class of cows that were being milked. Among the eighty-two patrons there were nineteen who were using pure-bred sires. The majority were breeding to grades of the beef type. A few patrons exhibited their lack of gumption by breeding to any kind of a bull that would get fresh cows. One man remarked that he did not know what kind of a bull he had last year, but that he had a good one this year. When asked the breed, replied: "Don't know; guess he's a Red Polled."

The lack of shelter, salt and pure water also contributed a share to the poor results obtained.

DAIRYING WITH COMMON COWS.

For a number of years this Station kept representatives of pure-bred dairy cattle. In giving the results obtained by these cattle to the public, the expression was frequently heard that the experiments carried on by our agricultural experiment station were with a class of cattle that an average Kansas farmer could not possibly possess and the results were of comparatively little value to him.

In January, 1898, the College bought a herd of common cows from Lincoln county, Kansas. These cows were bought by a man not especially versed as to the characteristics of a dairy animal. These did not represent the best dairy animals from the county, for the best

could not be obtained, as they were not for sale; they represented what we might call average cows. The illustrations of some of these cows as they appeared when they were brought to this Station are given in this bulletin, showing that they were certainly not above the average. Every effort was put forward to stimulate these cows in milk-production, and accurate records were kept of the milk produced and the feed consumed. The yield of milk, the test and the pounds of butter-fat produced from these cows are given herewith.

TABLE IV.— Yearly records of common cows.

Cow No.	Period covered by record.	Products.		
		Milk.	Average test.	Butter-fat.
		lbs.		*lbs.*
1	January 1, 1898 to January 1899	5,904.0	4.62%	272.70
1	March 1899 to March 1900	4,759.0	4.78	227.70
3	January 1898 to January 1899	5,864.0	3.99	233.90
4	June 1898 to June 1899	5,824.0	3.89	226.90
4	December 1899 to December 1900	4,473.4	3.80	170.43
5	January 1898 to January 1899	3,583.0	3.79	135.70
6	January 1898 to January 1899	6,269.0	4.09	256.40
6	April 1899 to April 1900	6,668.4	3.85	257.31
7	January 1898 to January 1899	7,015.0	4.43	310.80
7	April 1899 to April 1900	7,994.5	4.16	333.06
7	April 1900 to April 1901	6,966.4	4.80	334.55
8	February 1898 to February 1899	5,549.0	4.20	233.30
8	December 1899 to December 1900	6,361.6	4.30	273.63
9	January 1898 to January 1899	6,504.0	4.59	289.50
9	February 1899 to February 1900	5,188.1	4.49	233.29
10	January 1898 to January 1899	6,589.0	3.51	230.90
10	January 1899 to January 1900	4,454.6	3.80	169.44
11	January 1898 to January 1899	3,475.0	5.14	178.60
11	April 1899 to April 1900	5,947.3	4.84	288.17
12	February 1898 to February 1899	5,921.0	4.62	273.40
12	November 1899 to November 1900	6,249.9	4.71	295.46
14	May 1898 to May 1899	8,054.0	4.13	332.80
14	May 1899 to May 1900	5,610.0	3.97	223.23
14	June 1900 to June 1901	8,195.9	3.85	316.22
14	June 1901 to June 1902	5,705.4	3.76	214.91
14	June 1902 to June 1903	2,456.2	4.04	99.39
15	January 1898 to January 1899	6,509.0	4.27	277.90
16	January 1898 to January 1899	6,700.0	4.01	268.80
17	January 1898 to January 1899	5,238.0	3.97	207.80
18	January 1898 to January 1899	5,023.0	4.12	206.90
19	January 1898 to January 1899	3,913.0	4.14	161.90
20	January 1898 to January 1899	9,116.0	4.21	383.70
20	June 1899 to June 1900	8,675.6	4.17	361.82
20	August 1900 to August 1901	9,336.5	3.99	373.21
20	August 1901 to August 1902	8,288.7	4.02	331.57
20	August 1902 to August 1903	6,711.7	4.04	271.46
22	April 1898 to April 1899	5,960.0	3.77	224.80
23	April 1898 to April 1899	7,307.0	3.99	291.40
23	May 1899 to May 1900	7,072.4	3.99	282.21
23	May 1900 to May 1901	7,838.9	3.70	290.62
24	April 1898 to April 1899	5,742.0	3.48	199.80
24	April 1899 to April 1900	8,077.6	3.44	278.31
25	April 1898 to April 1899	5,952.0	4.23	251.50
26	April 1898 to April 1899	5,797.0	4.33	251.00
27	April 1898 to April 1899	4,200.0	3.96	166.30
28	April 1898 to April 1899	2,141.0	4.74	101.50
29	April 1898 to April 1899	3,730.0	4.23	157.80
30	April 1898 to April 1899	2,903.0	4.13	119.90
32	April 1898 to April 1899	4,039.1	4.32	174.60
33	April 1898 to April 1899	4,772.0	3.92	187.00
33	May 1899 to May 1900	8,184.9	3.71	303.84
33	June 1900 to June 1901	8,629.7	3.68	317.85
33	June 1901 to June 1902	7,325.8	3.63	266.34
33	June 1902 to June 1903	6,946.4	3.62	252.54
34	January 1900 to January 1901	5,400.7	3.83	207.22
34	January 1901 to January 1902	5,398.8	3.68	198.98
58	January 1902 to January 1903	3,330.6	5.03	167.65
59	January 1900 to January 1901	7,796.3	3.79	295.95

TABLE IV.—*Concluded.* Yearly records of common cows.

Cow No.	Period covered by record.			Products.		
				Milk.	Average test.	Butter-fat.
60	January 1900	to	January 1901	5,827.8	4.41	257.18
60	January 1901	to	January 1902	5,253.4	4.42	232.67
61	January 1900	to	January 1901	8,001.8	3.31	265.05
61	January 1901	to	January 1902	6,152.7	3.68	226.93
61	January 1902	to	January 1903	2,463.1	3.54	87.21
62	May 1900	to	May 1901	8,112.0	3.27	265.75
62	May 1901	to	May 1902	7,144.3	3.49	249.85
63	September 1900	to	September 1901	5,832.4	3.99	233.05
64	March 1900	to	March 1901	7,778.7	4.07	317.12
64	March 1901	to	March 1902	5,759.7	4.55	262.55
64	March 1902	to	March 1903	3,935.2	4.45	175.17
65	February 1900	to	February 1901	7,329.4	3.66	268.96
66	April 1900	to	April 1901	9,500.8	3.51	333.67
66	April 1901	to	April 1902	6,725.9	3.43	230.91
66	April 1902	to	April 1903	6,376.8	3.46	221.09
67	February 1900	to	February 1901	6,504.2	4.12	268.13
68	February 1900	to	February 1901	6,699.5	3.71	248.95
68	February 1901	to	February 1902	4,127.9	3.71	153.37
69	January 1900	to	January 1901	5,776.9	3.84	221.89
70	January 1900	to	January 1901	9,507.0	3.45	328.42
70	January 1901	to	January 1902	8,268.8	3.40	281.23
70	January 1902	to	January 1903	5,463.3	3.62	197.95
71	December 1899	to	December 1900	4,174.8	4.44	185.48
72	February 1900	to	February 1901	7,246.2	4.22	306.00
72	February 1901	to	February 1902	7,443.1	4.27	318.07
72	February 1902	to	February 1903	4,278.1	4.53	193.92
128	November 1900	to	November 1901	8,166.5	2.97	242.81
128	November 1901	to	November 1902	8,696.7	3.23	281.66
129	August 1900	to	August 1901	7,322.9	4.05	296.63
129	August 1901	to	August 1902	6,659.4	3.91	260.41
130	July 1900	to	July 1901	6,664.2	4.59	306.23
130	July 1901	to	July 1902	7,634.9	4.46	341.01
130	July 1902	to	July 1903	5,979.9	4.37	261.57
131	July 1900	to	July 1901	8,357.0	4.28	357.79
131	July 1901	to	July 1902	6,534.1	4.36	284.46
131	July 1902	to	July 1903	6,460.4	4.44	286.98
166	April 1901	to	April 1902	9,016.6	3.26	294.39
166	April 1902	to	April 1903	7,179.5	3.37	242.13
168	April 1901	to	April 1902	5,500.2	3.64	200.22
168	April 1902	to	April 1903	5,428.2	3.73	202.63
236	February 1902	to	February 1903	6,737.2	4.29	289.62
238	February 1902	to	February 1903	6,318.6	3.32	209.97
240	May 1902	to	February 1903	7,686.4	3.84	293 68
241	February 1902	to	February 1903	6,790.0	4.13	280.50
242	February 1902	to	February 1903	5,649.5	5.73	324.08
243	February 1902	to	February 1903	6,488.0	4.65	301.87
244	February 1902	to	February 1903	8,444.8	3.61	305.30
245	February 1902	to	February 1903	5,818.3	3.72	216.47
246	February 1902	to	February 1903	4,118.7	5.54	228.58
	Averages per cow per year			6,288.58	3.99	251.24

The figures in the above table are given to show the milk-production of common cows, and also to show the variations that take place in individuals. It will be noticed that some of the best cows are decreasing in their yields with advancing age. The variations in herds are shown under the creamery patrons' investigation. Some very interesting and instructive comparisons can be drawn from these individual cows. Table V shows the best yearly record from the best ten cows.

TABLE V.—Best yearly record of best ten cows.

Cow No.	Period covered by record.			Products.		
				Milk.	Average test.	Butter-fat.
				lbs.		*lbs.*
7	April 1900	to	April 1901.....	6,966.4	4.80%	334.55
14	May 1898	to	May 1899.	8,054.0	4.13	332.80
20	January 1898	to	January 1899	9,116.0	4.21	383.70
33	June 1900	to	June 1901	8,629.7	3.68	317.85
66	April 1900	to	April 1901..	9,500.8	3.51	333.67
70	January 1900	to	January 1901 ...	9,507.0	3.45	328.42
72	February 1901	to	February 1902 ...	7,443.1	4.27	318.07
130	July 1901	to	July 1902..... ..	7,634.9	4.46	341.01
131	July 1900	to	July 1901.	8,357.0	4.28	357.79
242	February 1902	to	February 1903....	5,649.5	5.73	324.08
	Averages per cow per year.....			8,085.8	4.17	337.19

In this table it will be noticed that even the best cows vary considerably in the yield of milk, the per cent. of butter-fat, and the total production of fat. The averages of these show that they are all excellent milkers; they produced 281 pounds of butter-fat above the average of the state, and 232.6 pounds of butter-fat above the average obtained in the creamery patrons' investigations.

The poorest yearly record, as given in table VI, shows some marked contrasts.

TABLE VI.—Poorest yearly record of poorest ten cows.

Cow No.	Period covered by record.			Products.		
				Milk.	Average test.	Butter-fat.
				lbs.		*lbs.*
5	January 1898	to	January 1899.....	3583.0	3.79 %	135.70
10	January 1899	to	January 1900.....	4454.6	3.80	169.44
19	January 1898	to	January 1899.....	3913.0	4.14	161.90
27	April 1898	to	April 1899	4200.0	3.96	166.30
28	April 1898	to	April 1899.....	2141.0	4.74	101.50
29	April 1898	to	April 1899.....	3730.0	4.23	157.80
30	April 1898	to	April 1899	2903.0	4.13	119.90
58	January 1902	to	January 1903.....	3330.6	5.03	167.65
61	January 1902	to	January 1903.....	2463.1	3.54	87.21
68	February 1901	to	February 1902....	4127.9	3.71	153.37
	Averages..			3484.62	4.07	142.077

The poorest cows also show considerable variation among themselves, as well as the best ten cows. Narrowing the two comparisons down to a still smaller number of cows, we have the results obtained in table VII.

TABLE VII.—Best five and poorest five cows compared.

	Products.		
	Milk.	Average test.	Butter-fat.
	lbs.		*lbs.*
Averages of the best five cows.....	8,255.02	4.24%	350.14
Averages of the poorest five cows	3,043.60	3.92	119.53
Differences.....	5,211.42	.....	230.61

It is still interesting to note the differences between the best cow and the poorest cow. These are given in table VIII.

TABLE VIII.—Best cow and poorest cow compared.

	Products.		
	Milk.	Average test.	Butter-fat.
	lbs.		*lbs.*
Best cow (No. 20)	9,116.0	4.21%	383.70
Poorest cow (No. 61)	2,463.1	3.54	87.21
Differences	6,652.9	.....	296.49

THE PROFITS. As with the herds so with the individuals: the total production does not tell anywhere near the entire story. We must deduct the cost of feed. In figuring the cost of feed there are two methods employed: First, charging up all feeds at the local price in Manhattan at the time the feeds were purchased. The other is taking the average price obtained by our farmers, which we have assumed to be fifty cents per hundred for grain and four dollars per ton for hay. Where feed is charged at the local prices, it should be borne in mind that there are two sources of profit: First, from raising feed; and second, the profit from using that fed through the medium of the cow, to be converted into milk and butter-fat. So, when we figure up the income for dairy cows, we must also bear in mind that the cows are also furnishing us a good market for the farm products besides returning a great deal of fertility to the land.

Taking the above summaries of the oows from the College herd, and giving them credit for butter-fat produced at creamery prices, skim-milk at fifteen cents per hundredweight, and charging them with the feed consumed, we have the results obtained in table IX.

TABLE IX.—Profits after deducting cost of feed.

	Income from dairy products.	Cost of feed.		Profits.	
		Local retail prices.	Farm prices.	Local.	Farm.
Averages per head of ten best cows	$68 61	$48 92	$16 74	$19 69 gain.	$51 87 gain.
Averages per head of ten poorest cows,	28 30	29 04	11 73	72 loss.	16 57 gain.
Differences	$40 31	$19 88	$5 01	$20 41	$35 30
Averages per head of five best cows	$70 03	$49 26	$17 23	$20 77 gain.	$52 80 gain.
Averages per head of five poorest cows,	23 76	28 34	11 58	4 58 loss.	12 18 gain.
Differences	$46 27	$20 92	$5 65	$25 35	$40 62
Best cow (No. 20)	$73 17	$32 80	$18 88	$40 37 gain.	$54 29 gain.
Poorest cow (No. 61)	22 51	27 04	11 92	4 53 loss.	10 59 gain.
Differences	$50 66	$5 76	$6 96	$44 90	$43 70

An examination of this table reveals the fact that very little more feed is required for a good cow than for a poor one. It also shows the possibilities in the way of profits where the feeds are raised and fed on the farm, charging the cow a fair price for them there, and eliminating the expense of hauling to and from market.

After deducting the cost of feed, it will be seen that there is a very great difference in the balance that is left in the different classes of cows. It shows that one good cow is worth a good many poor cows. It shows that a small herd of choice cows are worth several herds of medium or poor cows. It emphasizes the fact that we must look for better cow machines if we are to get the best results from dairying. It shows that, under the same treatment, with the same care, some cows have the capacity to convert feed into milk at a profit, which in some cases may be a large profit, while others utilize their feed at a loss or at a very small profit.

Under the creamery investigation we found great variation in herds. With the common cows at the Kansas State Agricultural College we find great variations in individuals. From these two studies we see the great possibilities for improvement, and we can see how it is possible for a man to weed out his poor cows so as to get a herd that will not only be a joy and a pleasure to handle but will mean much more money in his pocketbook.

Change in Appearance. At the same time these common cows were making the records given above; a change was also taking place in their outward appearance, as is shown in the cuts accompanying this bulletin. The form of the cows underwent a transformation. When they arrived at the College the underline of some of them seemed to have an upward curve, but by receiving good feed and good care the underline was changed to a downward curve. These changes in their appearance show that it is possible to materially improve the cows that we now have by feed and care.

Results with cows selected by dairymen.

During the winter of 1901 and 1902 the College was in need of some more milch cows, and since the previous cows were selected by a man not a dairyman, it was thought to be an interesting feature to have some cows that were selected by dairymen who had made good records with handling cows themselves. Nine different dairymen were asked to select the best cow that could be laid down at Manhattan for fifty dollars, each man being required to make the selection outside of his own herd, so as to prevent him from sacrificing a good cow of his own in order to have his cow make a good record at the College. Where the distances were so far that the freight amounted

to more than ten dollars, the party making the selection was allowed to have forty dollars to pay for the cow at his home, no matter what the freight might be. These cows were all delivered before the 1st of March, 1902, and the names of the persons making the selection, together with their post-offices, county, name and age of the cow are as follows:

NAME.	Post-office.	County.	Name of Cow.	Age.	Fresh.
J. W. Bigger.....	North Topeka..	Shawnee....	Cowslip.....	7 years,	Nov. 3, '01.
E. C. Cowles.....	Sibley.....	Douglas....	Haster.....	6 years,	Dec. 10,'01.
J. W. Cunningham.	Meriden.....	Jefferson...	Rose of Cunningham..	5 years,	Jan. 28,'02.
M. L. Dickson.....	Edgerton.....	Johnson....	Clover Leaf.....	8 years,	Jan. 12,'02.
A. H. Diehl.....	Chapman.....	Dickinson..	Molly.....	7 years,	Jan. 20,'02.
C. Elsasser	Industry.....	Clay	Rose of Industry.....	7 years,	Jan. 15,'02.
S. A. Johnson.....	Cleveland.....	Kingman...	Daisy Bell.....	6 years,	Mar., '02.
C. C. Lewis.....	Ottawa.....	Franklin...	Floss.....	5 years,	Oct., '02.
G. W. Priest*.....	Meriden.....	Shawnee....	May Queen.....	5 years,	Dec. 25,'01.

*Post-office, Jefferson county; farm, Shawnee county.

These cows were judged by three experts: Maj. Henry E. Alvord, chief of dairy division, United States Department of Agriculture, Prof., A. L. Haecker, of the University of Nebraska, and Mr. T. A. Borman, of Topeka, Kan., and were placed in the order in which they thought these cows would turn out in regard to profit at the end of the year. The results of every month were published at the end of the month, and as these cows were judged at the time of the State Dairy Association, a large number of visitors and students were interested in the outcome and watched these monthly reports closely. The year's record of these cows is given in table X.

It will be noticed that several of these cows are very close together, both in the yield of milk and butter-fat. The lowest yielder in the bunch produced over 200 pounds of butter-fat in the year. In feeding these cows an exact record was kept of the grain consumed by each individual. It was impracticable to keep individual records of the roughness, but the total roughness was accurately kept, and charged to these cows. A record of the feed consumed is given in table XI.

In feeding these, cows the aim was to give them practically all the roughness they would eat and all the grain they would handle at a profit. It will be noticed that the grain varied somewhat with the different cows. As the weights of these cows varied considerably, it hardly seemed fair to charge them equally for roughness, and, in order to regulate this, table XII has been worked out, charging the roughness in proportion to the average live weight of the cow.

TABLE X.—Year's record of cows selected by dairymen.

College No.	NAME OF COW.	Fresh.	Products.			Rank.	
			Milk.	Average test.	Butter-fat.	Judges.	Year's record in butter-fat production.
			lbs.		*lbs.*		
243	Cowslip	November 3, 1901 January 10, 1903	6,285.5	5.00%	314.33	3	2
236	Haster	December 10, 1901 December 5, 1902	5,663.5	4.85	274.89	1	4
244	Rose of Cunnigham	January 28, 1902 January 29, 1903	8,107.5	3.99	324.18	2	1
238	Clover Leaf	January 12, 1902	5,530.9	3.62	200.28	7	9
245	Molly	January 20, 1902 February 12, 1903	5,096.9	4.36	222.30	5	8
241	Rose of Industry	January 15, 1902 February 12, 1903	5,972.9	4.57	273.17	8	6
240	Daisy Belle	April, 1901 May 3, 1902	6,329.7	4.31	273.24	9	5
246	Floss	October, 1901 Novemer 10, 1902	4,230.0	5.95	251.90	6	7
242	May Queen	December 25, 1901	4,809.9	6.41	308.74	4	3

TABLE XI.—Feed consumed by cows selected by dairymen.

NAME OF COW.	Grain fed, pounds.			Roughness fed, pounds.								Total pounds.
	Bran.	Corn chop.	Total.	Alfalfa.	Kafir-corn stover.	Green alfalfa.	Cow-pea hay.	Millet hay.	Ensilage.	Cut cane.	Oat hay.	
Cowslip	1,524	459	1,983	3,295	924	110	324	596	601	681	63	6,594
Haster	1,569	474	2,043	3,295	924	110	324	596	601	681	63	6,594
Rose of Cunningham	1,801	563	2,363	3,295	924	110	324	596	601	681	63	6,594
Clover Leaf	1,032	330	1,362	3,295	924	110	324	596	601	681	63	6,594
Molly	1,129	316	1,445	3,295	924	110	324	596	601	681	63	6,594
Rose of Industry	1,226	411	1,637	3,295	924	110	324	596	601	681	63	6,594
Daisy Belle	1,120	576	1,696	3,295	924	110	324	596	601	681	63	6,594
Floss	1,124	255	1,379	3,295	924	110	324	596	601	681	63	6,594
May Queen	1,475	527	2,002	3,295	924	110	324	596	601	681	63	6,594

TABLE XII.—Roughness consumed by cows selected by dairymen in proportion to live weight.

NAME OF COW.	Average live weight.	Roughness consumed in proportion to weight.
	lbs.	*lbs.*
Cowslip	1,033	6,924
Haster	866	5,805
Rose of Cunningham	1,293	8,667
Clover Leaf	752	5,040
Molly	1,275	8,546
Rose of Industry	1,001	6,709
Daisy Belle	977	6,545
Floss	812	5,443
May Queen	845	5,664

It is interesting to note the weights and gains of these cows during the experiment, which lasted from March 1, 1902, to March 1, 1903.

TABLE XIII.—Weights and gains of cows selected by dairymen.

NAME OF COW.	Weight.		Gain, lbs.
	March 1, 1902.	March 1, 1903.	
Cowslip	973	900	—73
Haster	800	830	30
Rose of Cunningham	1,152	1,306	154
Clover Leaf	717	739	22
Molly	1,100	1,225	125
Rose of Industry	866	1,043	177
Daisy Belle	926	1,042	116
Floss	685	799	114
May Queen*	738	958	220

*May Queen calved in March, 1903.

Charging up the actual amount of grain consumed and the roughness in proportion to the live weight, and giving credit for butter-fat produced at 21 cents per pound, skim-milk at 15 cents per 100, the value of the calf at birth, and the gain in live weight at 4 cents per pound, we have the results given in table XIV.

It is interesting to know the amount and value of the feed consumed per 100 pounds of butter-fat produced. This is given in table XV.

DAIRYING WITH GRADE COWS.

The Kansas Station has not had its herd long enough to show much results from the grades. The common cows that we purchased in Lincoln county have been graded up by the use of pure-bred Guernsey bulls. The first one was Campbell's King 4951; his dam, Yeksa's Queen 6631, has a butter record of 600 pounds in one year. This bull was succeeded by Shylock of Darlington 4579; his dam, Nubia's Vesta 5986, has a record of 556 pounds of butter in six months. Mr. J. F. Schlappi, who was superintendent of the feeding department in the Pan-American dairy test, while in attendance at the Kan-

TABLE XIV.—Financial statement of cows selected by dairymen.

NAME OF COW.	DEBITS.				CREDITS.				Returns, less cost of feed.		Rank.	
	Cost of feed.											
	Grain.		Roughness.		Butter-fat, at 21.25 cents.	Skim-milk, at 15 cents per 100 lbs.	Value of calf at birth.	Gain, live weight, at 4 cents per lb.	Local.	Farm.	Local.	Farm.
	Local.	Farm.	Local.	Farm.								
Cowslip	$19 21	$9 91	$25 29	$12 73	$66 79	$9 23	$5 00	—$2 92	$33 60	$55 46	6	5
Haster	19 70	10 21	21 20	10 67	58 41	8 52	5 00	1 20	32 14	52 25	7	7
Rose of Cunningham	22 90	11 81	31 66	15 93	68 89	12 03	5 00	6 16	37 52	64 34	3	2
Clover Leaf	13 20	6 81	18 41	9 26	42 56	8 02	5 00	88	24 85	40 39	8	9
Molly	14 00	7 22	31 22	15 71	47 24	7 73	5 00	5 00	19 75	42 04	9	8
Rose of Industry	15 86	8 18	24 51	12 33	58 05	8 80	5 00	7 08	38 56	58 42	2	3
Daisy Belle	16 43	8 48	23 92	12 04	58 06	9 68	5 00	4 64	37 03	56 86	4	4
Floss	13 36	6 89	19 38	10 00	53 53	6 16	5 00	4 56	36 01	52 36	5	6
May Queen	19 40	10 00	20 69	10 41	65 61	7 23	5 00	8 80	46 55	66 23	1	1

NOTE TO TABLE XIV.

Roughness figured in proportion to live weight: It will be noticed that, in figuring the results indicated in table XIV, it changes the rank of the cows from that given in table X. It also makes a difference in rank whether the feeds are figured at local prices or whether they are figured at farm prices, due to the local prices changing from month to month. In table X, Rose of Cunningham ranked first in total production of butter-fat. In table XIV, where she is charged for roughness in proportion to live weight, she ranks third and second. In similar manner Cowslip ranks second in table X and sixth and fifth in table XIV. Rose of Industry, which ranked sixth in table X, ranks second and third in table XIV. Haster, that ranks fourth in table X, ranks seventh in table XIV. In a similar manner the entire nine cows have one or more changes in rank. These changes, due to the manner in which the feed is charged to the cow, enable two cows to claim first honors, and three cows second honors.

TABLE XV.—Feed consumed in proportion to butter-fat produced.

NAME OF COW.	Butter-fat produced.	Feed consumed.		Feed consumed per 100 lbs. of butter-fat produced.		Cost of feed per 100 lbs. of butter-fat produced.	
		Grain.	Rough-ness.	Grain.	Rough-ness.	Local.	Farm.
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*		
Cowslip	314.33	1,983	6,924	630.56	2,202.51	$14 16	$7 20
Haster	274.89	2,043	5,805	743.20	2,111.35	14 92	7 60
Rose of Cunningham	324.14	2,363	8,667	728.91	2,673.10	16 83	8 56
Clover Leaf	200.28	1,362	5,040	680.04	2,516.43	15 78	8 03
Molly	222.30	1,445	8,546	650.02	3,843.92	20 34	10 32
Rose of Industry	273.17	1,637	6,709	599.26	2,455.86	14 78	7 51
Daisy Belle	273.24	1,696	6,543	620.69	2,396.36	14 77	7 51
Floss	251.90	1,379	5,443	547.48	2,160.38	13 20	6 71
May Queen	308.74	2,002	5,664	648.44	1,834.28	12 98	6 61

sas State Dairy Association, scored this bull before the class, and gave him a score of 98 points out of a possible 100. He said: "I would not want an animal of better shape, and it would be hard to find an animal with better skin and hair than this animal has. I think this animal is a very fine one, and good enough for any man's herd. The College ought to be congratulated upon having such a fine animal." There are a few records of Campbell King's heifers recorded in table XVI. The records of their dams are inserted for comparison.

TABLE XVI.—Records of half-Guernsey heifers and their dams.

Cow No.	Milk.	Butter-fat.	Butter-fat.
	lbs.		*lbs.*
Half-Guernsey, No. 43; age, 2 years 8 months	4,088.0	4.44%	181.84
Dam, No. 26	5,797.0	4.33	251.00
Half-Guernsey, No. 46; age, 2 years 11 months	2,984.7	5.29	157.10
Dam, No. 7	7,994.5	4.16	333.06
Half-Guernsey, No. 47; age, 2 years 7 months	7,684.6	4.27	328.30
Dam, No. 25	5,952.0	4.23	251.50
Half-Guernsey, No. 52; age, 2 years 10 months	5,987.2	4.23	252.44
Dam, No. 24	8,077.6	3.44	278.31
Half-Guernsey, No. 53; age, 2 years 5 months	5,910.3	4.11	243.38
Dam, No. 33	7,325.8	3.63	266.34
Half-Guernsey, No. 77; age, 3 years 4 months	7,602.3	4.17	317.64
Dam, No. 4	5,824.0	3.89	226.90

It will be noticed that two of these heifers made a comparatively poor record the first year. We are keeping them, with the thought that perhaps in another year they may make a very fair showing.

It will be noticed that the best records of these grade Guernseys are with animals descended from good dams. There are exceptions to this, as is shown in No. 46, who was out of a remarkably good common cow, No. 7. She aborted the first year, which partially accounts for her first year's record; but even in her second year she is not doing what we had hoped she would. Young heifers will usually improve in the second and third lactation periods, and so should not be discarded or judged too severely upon their first year's record.

These results go to show that we do not always get what we want in breeding, even though we have good ancestry, but the results shown in table XVI would undoubtedly have been less encouraging had the ancestry been poorer. Because we get poor results at times is no reason for not exercising constant care in selecting our breeding stock and in weeding out the poor animals. There is no question but that we will get a larger per cent. of desirable heifers when we breed from the best. While a common cow may give excellent results at the pail, there is no assurance that she will transmit her qualities to her offspring. Illustration is given in the cases of cows Nos. 5 and 20,

whose results are published above. When purchasing these cows we were told that No. 5 was the daughter of No. 20. No. 20 is the best cow in the common herd, and No. 5 ranks among the very poorest. Common cows should be used simply as a stepping-stone to something better. If we attempt to maintain the herd without improving it we will find that we are retrograding. Every year should witness a decided rise in the average production of the herd.

IMPORTANCE OF A GOOD SIRE. The sire is frequently spoken of as half of the herd. If he is a good one he is more than half, as he will stamp his qualities upon his offspring, and on account of his prepotency the offspring will generally take more after the sire than after the dam.

THE QUESTION OF BREED. Numerous inquiries reach this Station relative to the best breed for crossing upon our common cows. The question of breeds has been a disputed question ever since breeds existed and will doubtless continue to be for all time to come. If the breed is being graded up for dairy purposes, there is no question but what the sire should be prepotent along dairy lines, and in selecting this sire it is well to see whether he has descended from high-pro ducing cows. After eliminating the beef breeds, the question of breed depends more upon the breed of the man than upon the breed of the cow. We frequently find more difference between individuals of the same breed than we do between the different breeds.

Any of the dairy breeds can furnish sires that are vastly superior to those from grade or common cows. The dairy interests of Kansas have shown, from the average production of her cows, that her dairy farmers need to use a sire that will stamp his qualities in a way that will show at the milk scale and at the Babcock test, and every dairy-farmer should feel that he is committing a crime when using anything but a first-class sire at the head of his herd. Life is too short to attempt to grade up a herd of common cows with a common bull.

The best record under the creamery patrons investigation was made by a man who has been grading up along dairy lines for several years. The fact that his cows averaged $8.50 per head more than the next best herd, and $14 more per cow than the fourth-best herd, and $21.50 more than the average patron's cow, speaks well for his method of breeding as well as for his feeding and care.

For several years this Station has been collecting records of different dairymen. In this collection we have the statement of one of the most successful men in the handling of cows in the state of Kansas. He is quoted as follows: "An old red cow dropped two heifer calves in succession, one a half-grade Holstein, the other from a Short-horn bull. The Holstein heifer with a third calf produced an average of

fifty-two pounds of three and eight-tenths-per cent. milk for seven days; and, for the same time, the red heifer with second calf gave twenty-seven pounds of four-per cent. milk per day. The cows were half-sisters, one producing two and three-tenths pounds of butter per day, the other one and two-tenth pounds; the first milking eleven months of the year, the second dry at five months." "This instance," says he, "only serves to demonstrate the value of a sire bred for milk and butter, when the farmer is rearing a dairy herd."

Choice cows can seldom be bought at reasonable figures, unless it be at a dispersion sale; the owners know their worth and will not part with them. This being the case, the only way we can get a satisfactory herd is to raise it. This is not only more satisfactory but it is much more economical.

In breeding dairy cows a man should have a definite object in view. Too many shift from beef to dairy when dairy products are high and beef products are low, and then shift back again from dairy to beef when beef rises in value. By this method a man is constantly shifting from one breed to another, and as a result he is getting a herd that is good for neither milk nor beef. A man must have an ideal toward which he is breeding and then bend all his energies to that end. This shilting from one breed to another is a suicidal policy that will ruin any man and any herd.

IMPORTANCE OF A GOOD DAM. A great deal of stress has been placed on the importance of a good sire but comparatively little has been said in regard to the breeding qualities of the dam. While these are not relatively of as great importance as the sire's, they nevertheless should reoeive careful consideration. We cannot expect to get the best results from inferior dams, even if the sires are good. The weeding out of the poor cows then has a twofold importance: First, in raising the average production of the herd, and not letting a few unprofitable cows bring down the average so as to make the whole herd appear unprofitable; and second, seek to raise the standard of our breeding stock by furnishing both sire and dam of good breeding and individuality.

DAIRYING WITH PURE-BREDS.

The Kansas Agricultural College has representatives of ten breeds of pure-bred cattle: Four beef, four dairy, and two general purpose. These cattle are kept largely for class illustration in stock judging. In order to see what these cows were doing the beef animals as well as the dairy animals were milked, their calves being raised by nurse cows from the common herd. The results we have gained thus far are given in table XVII.

TABLE XVII.—Records of dairy, beef and dual-purpose pure-breds.

BREED.	NAME.	Products.		
		Milk.	Average test.	Butter-fat.
		lbs.		*lbs.*
Ayrshire	Maggie of Woodroofe	5050.7	4.04%	204.17
Ayrshire	Star of Hillview	8862.5	4.08	361.78
Galloway	Dantling	1902.0	4.46	85.00
Guernsey	Countess Vesta	5092.8	4.47	227.76
Jersey	Miss Minute	5215.2	4.95	258.17
Jersey	Miss Ita	5742.2	4.83	277.81
Red Polled	Juno	4862.7	4.46	217.07
Red Polled	Upshot	4578.4	4.29	196.42
Short-horn	Easter Lilly	2368.9	4.57	108.36
Short-horn	Mary of Elderlawn	3967.6	4.43	176.02
Hereford	Perfection Maid	1079.9	4.04	43.62
Holstein-Friesian	College Gerben	6968.0	3.30	230.33

Most of these cows are young and the records given here in many cases are for the first lactation period. It will be noticed, however, that the beef animals, while they had a very fair test, produced a very small quantity of milk. In the cases of Perfection Maid and Dantling, we kept milking them considerably longer than the receipts of milk would justify in order to see just what they would do.

Special attention is called to the record of Star of Hillview, an Ayrshire cow, that produced during the year 8862 pounds of milk and 361.7 pounds of butter-fat. Counting a pound to a person per week, this is more than enough butter to feed a family of eight an entire year: It is such cows as this that please the dairymen, and a few cows of this kind are worth more to a man than a herd of medium or poor cows.

Not unfrequently we hear a dairyman claim that he has a common cow that will outyield pure-breds, and again we hear of pure-breds that are very poor milkers. There is no question but that both of these statements are more or less true. They are partially borne out when comparing table XVII with tables IV and V. Because there is now and then a common cow that rises above the average of her kind and makes a phenomenal record, and because there are some pure-bred cows that fall short and do not make a good showing, is no reason why we should say there is no object in working for pure-bred animals. There is no question but that there are all too many scrubby cows that are registered, and if one has the choice between these and a good common or scrub cow, a man would not be blamed if he selected the scrub cow. We must not forget, however, that there are pure-bred cows that have never been equaled and probably never will be by scrub cows. Cattle bred along a particular line will be more apt to transmit their qualities to their offspring and will have the power to convert feed into dairy products more economically than common cows. Just as the primitive locomotive would be incapable of pull-

ing our modern train of cars, no matter how much fuel and oil should be used, so a primitive or unimproved cow does not meet our requirements, and we must look to pure-breds to furnish the stock which shall increase the standard of our herds. With pure-breds there is the additional advantage of being able to sell the male calves for breeding purposes. Recently this College sold a Jersey calf for fifty dollars, which, if it had not been a pure-bred, would have brought from five to eight dollars.

ACCURATE RECORDS AS A BASIS FOR WEEDING OUT UNPROFITABLE COWS

Whether the cows are common, grade, or pure-bred, vigorous selection must still be practiced. In order to select intelligently, it is necessary that accurate records be kept of the cow's performance. It is not enough to know what the herd averages, but we must be able to pick out the poor cows that are bringing the average of the herd down, A man may think he knows his best cow without bothering with the milk-scales and the Babcock test, but the experience of those who have tried it both ways goes to say that he does not always know; frequently the cow that he thinks the best turns out the poorest.

A man may say that he does not have time to keep records. Experience at this Station shows that it takes about twelve seconds to record a cow's milk, and the extra pains that a milker will take when keeping a record will more than make up for the time. The keeping of accurate records is at the foundation of profitable dairying. Without it we can do little toward improving and raising the standard of our dairy herd. We need to know the amount of feed that each cow consumes, and then, by the knowledge of her milk, with the per cent. of butter-fat, we can increase or decrease her feed in accordance with the element of profit. The sooner we apply the milk-scales and Babcock test and weed out the unprofitable cows, the sooner we will be able to place the herd on a more profitable basis.

VARIATIONS IN WEIGHTS OF ANIMALS.

Weights, or the variation in weight, has very little to do with the profit side of dairy cows, except when they may be sold to the butcher or feeder, to be put in readiness for the block; however, there are a number of cows and calves that are bought by weight, and it is well for every farmer to know something of the fluctuations that may take place in weight from time to time. In two different months the Agricultural College dairy herd was weighed for three consecutive days, and the weight of each animal determined by averaging the results of three days' weighing. Two tests were made—one where the cattle did not have access to water until after they were weighed; and a

second, where they were allowed to run to the watering-trough on the way to the scales.

VARIATION WITH COWS GIVING MILK. The average weight of thirteen cows was 1048 and 1065 pounds, respectively, for the first and second weigh periods. During the first period the minimum variation of any one individual was four pounds and the maximum sixty-five pounds, with an average for the lot of twelve pounds. During the second period, where the herd had access to water, the minimum variation was five pounds and the maximum ninety pounds. During this period certain cows gained at the same time that others lost, so that the average variation for the lot was only five pounds, the same as the minimum variation of any one individual. In both periods the greatest variation took place with animals that weighed from 900 to 950 pounds.

VARIATION OF DRY COWS. Twelve cows were weighed for this test, and the results show that minimum variation for any single individual was seven pounds and the maximum thirty-two pounds, with an average of seven pounds. In the first period the greatest variation was with a 960-pound cow and in the second with a 1300-pound cow.

VARIATIONS WITH YOUNG STOCK. This lot consisted of five head whose weights ranged from 400 to 600 pounds. In the first period the minimum was seven pounds and the maximum twenty-nine pounds, with an average of twenty-three pounds. During the second period the minimum was thirteen with a maximum of twenty-four, and the variation among individuals was balanced so that the average variation was only two pounds.

VARIATION WITH CALVES. Four head were used, ranging in weight from 85 to 165 pounds, The variation ranged from two to five pounds, with an average for two periods of two and one half pounds. The greatest variation in this case was with the smallest calf.

VARIATION WITH THE BULL. The pure-bred Guernsey bull Campbell's King had an average weight in the first period of 1342 pounds, with a difference between his highest and lowest weights of forty-two pounds. In the second weigh period his average weight was 1355 pounds, with a variation of nineteen pounds.

The above notes show that considerable variation may take place in the consecutive daily weights of the same animal without any apparent cause. If a person is particular in giving accurate weight of an animal, it should be by at least three successive daily weighings.

OBSERVATIONS FROM THE COLLEGE DAIRY HERD.

During the past four years there have been many experiences that have presented themselves in the handling of the College milch cows. As we believe these experiences are of interest and value to the dairy farmer we give them herewith.

WEIGHT *VS.* YIELD. The question has been frequently raised as to whether a heavy, medium or light cow is the best producer. In the common herd at this College there are both medium and heavy cows, but comparatively few light ones. We give in the following table the results we have obtained with the different weights of cows, but these figures must not be taken as in any way conclusive, as the number from which these were taken was limited:

TABLE XVIII.—Records of heavy, medium and light cows.

CLASS.	Number of cows considered.	Average yield.		
		Milk.	Test.	Butter-fat.
		lbs.		*lbs.*
Heavy	Five	6571.40	3.88%	255.14
Medium	Five	7702.03	3.95	304.40
Light.	Five	6405.58	4.56	292.24

On account of limited funds it has been impracticable to weigh the roughness fed separately, but we have weighed the grain separately, and it is interesting to note the amount of grain consumed by small and medium cows in comparison with the amount consumed by heavy cows. The results show that the five heavy cows consumed 1768 pounds per head per annum, or 693 pounds of grain per 100 pounds of butter-fat produced; the medium cows consumed 2349 pounds of grain per head per annum, or 771 pounds per 100 pounds of butter-fat produced; and the light cows 2267 pounds of grain per head per annum, or 775 pounds per 100 pounds of butter-fat produced.

The variations in the monthly gains of beef vs. dairy type of cows is interesting and has been compiled from the record of five cows of each type. The five beefy cows produced an average of 249.8 pounds of butter-fat per cow per annum, and during the same period gained 212.8 pounds of flesh per head. The dairy-type cows produced 335 pounds of butter-fat per cow per annum and lost an average of thirty pounds in weight.

VARIATIONS IN THE DAILY YIELD OF MILE. There is considerable fluctuation in the amount of milk yielded by a herd from day to day. An interesting observation was made at this Station for seven days with seven cows milked by one milker. We give the table in pounds per day.

TABLE XIX.—Variations in the daily yield of milk from cows milked by the same man.

Pounds of milk from seven cows.	Days.						
	1	2	3	4	5	6	7
lbs.	144.4	136.8	131.7	126.4	119.7	139.8	138.1

This test was made during the first week in August. Notes on the weather show that it was moderately warm on the first and second days, hot on the third, fourth, and fifth, and cool on the sixth and seventh, from which it would appear that the variation was affected somewhat by the temperature, the yield going down on hot days, when the cows did not eat so well and the flies were more troublesome. The hot weather also has a depressing effect on the cow; this indicates that it is desirable to make the cows as comfortable as possible. Long drives back and forth from pasture during hot weather are very detrimental to good yields.

To still further show the variation in yields that may occur, the following total yields from thirty-six cows were taken from the College herd for seven days during the month of February:

TABLE XX.—Variations in the daily yield of milk from herd.

Pounds of milk from thirty-six cows.	Days.						
	1	2	3	4	5	6	7
lbs.	606	592.5	669.7	672.9	680.7	712.7	718.9

PROFITS FROM LONG *VS.* SHORT LACTATION PERIODS.

It is comparatively easy, when pastures are dry and feed a little scarce, for the cows to materially decrease in their milk yield and even shorten their lactation period. The advisability of having a cow with a long lactation period is shown in table XXI.

TABLE XXI.—Showing income from cows with long *vs.* short lactation periods.

Lactation Period.	Number of cows considered.	Income.		Cost of feed.		Income less cost of feed.	
		Butter-fat.	Value.	Local.	Farm.	Local.	Farm.
		lbs.					
Long.....	Five.....	323.83	$68 61	$54 11	$31 48	$14 50	$37 13
Short.....	Five.....	212.77	48 24	42 24	27 13	6 01	21 11

From this table it will be noticed that the largest profit comes with the longest lactation period, and for this reason it is advisable to maintain the lactation period, even though in order to do so it is necessary to feed extra when pastures are scarce, and possibly, for the time be-

ing, feed at a loss. The reason for keeping up this flow is twofold: First, after the yield is decreased it is very difficult if not impossible to restore it; and second, a decrease is liable to shorten the lactation period.

WEIGHING THE MILK OF INDIVIDUAL COWS.

Experience shows that it is impossible to get the correct estimate of the value of a cow without weighing and testing the milk. The weighing need not be done at every milking, although it is desirable, and the experience at the Agricultural College indicates that the time lost in weighing is more than gained by the interest that the milkers take in their work when they weigh the milk. The position of milker at the College has been in demand, and not unfrequently there is a lively competition between the different milkers to see whose cows will give the most milk. Each one has an interest in getting his cow to increase in yield, and in order to do this will milk faster and milk cleaner. Again, when each milking is weighed, it gives an opportunity for the milker to see any variation that takes place from day to day, and as he sees the variations he looks around to find the cause, and frequently an unfavorable cause can be remedied or a favorable one stimulated so as to increase the receipts of the herd. In this way zeal is added to the milking hour and the task becomes a pleasure instead of a drudgery. The time required to weigh, record and sample each milking is not near as much as one might think. We have weighed the milk from twenty-three cows in eight and one-half minutes, which is equivalent to a trifle more than twenty-two seconds to a cow. The man who knows what his cows are doing and who will study to improve the conditions favorable to good yields will receive ample returns for his work.

COST OF KEEPING A COW.

This undoubtedly varies greatly in different localities, and it would be folly to lay down arbitrary figures in dollars and cents. It is just however, to charge the cow with the cost of feed at market prices, minus the expense of hauling. This does not take into consideration the fertilizing income derived from feeding the products to the cow, Results at this Station show that with twenty-eight cows there was an average of 2350 pounds of grain and 6166 pounds of roughness consumed per cow per annum. In figuring the cost of keeping a cow the labor is also an important item. Statistics collected by this department from a number of prominent dairymen indicate that it requires an average of 125 hours per cow per annum to milk, feed, clean stables, and wash milk utensils. At ten cents per hour (a very low

figure for labor) this amounts to $12.50 per annum; eight per cent, interest on a $40 cow would be $3.20.

Risks from failure to breed and from losses of calves by death have been estimated to be $2.75 per annum per head for beef animals. Probably the same ratio would hold true with dairy animals also. We must, of course, credit the cow with the calf, which we assume to be $20. The cost of raising the calf, to six months of age, from the results obtained at the Kansas Station, amounts to about $7.50. Adding together the cost of labor, interest on the money invested, the loss from failure to breed, the loss of calves by death, and the cost of raising the calf until six months of age, we have a total of $25.95. Substract from this $20, the value of the calf, and we have a remainder of $5.95 to be charged up to the cow. In other words, a dairy cow, to be really profitable, must yield products to the amount of $5.95 above the cost of feed.

This emphasizes the folly of attempting to run a dairy with poor cows. No business man would put more capital into.a business than he would expect to utilize at a profit.

WHEN WILL IT PAY TO MILK A COW?

Having cows of various ages and capacities on the farm, the question arises as to when it will pay a man to milk the cow and raise the calf on skim-milk. Since it costs about $12.60 per cow to pay for the work connected with milking, and from $7 to $8 to raise the calf on skim-milk, a cow must produce, in order to be profitable, at least $20 worth of butter-fat before it will pay to milk her, assuming that the skim-milk pays for the hauling. With four-per-cent. milk and fifteen cents for butter-fat, this would mean 3333 pounds of milk per annum; with eighteen-cent butter-fat it would be 2777 pounds of milk per annum, and with twenty-cent butter-fat it would be 2600 pounds of milk. This is assuming that a dairy cow would eat no more when giving milk than she would when not. Doubtless she would eat some more, and this would have to be added to the above cost.

These figures give a man an idea of when he can afford to take the cows that are nursing calves and put them into the dairy herd. If they do not at least come up to the above standard, they had better be left where they are.

HANDLING THE DAIRY BULL.

The experience of the Kansas Agricultural College with bulls indicates that it is not safe for a man to take any risks, even though the bull may appear gentle. One of our careful and paintakings herdsmen was forced up to a stone wall by a bull that had pushed the gate

open while the herdsman was endeavoring to catch him with the bull staff, and, although this herdsman had tried to be very careful, a little carelessness in seeing that the gate was not fastened until he had the bull caught came very near costing him his life. It is comparatively easy for a herdsman to get careless while handing a gentle bull, but while he may think him perfectly safe he is nevertheless dangerous; tame bulls do the damage. A good, strong ring in the nose has much to do in taming a bull; if this is not enough, a chain attached to this ring and dragging on the ground will result in his stepping on it from time to time and aids very materially in holding in check his vicious disposition. Usually this chain can be reached with the bull staff and so help in catching him.

The only safe plan to follow is for the herdsman never to go into the yard without having some form of protection, as a pitchfork or a sharp pointed prod; and if the bull shows signs of being disagreeable it would be better to have two persons around when an effort is made to catch him. A bull should always be handled so as to let him know that the herdsman is master, The bull's disposition is greatly improved by currying and by offering him apple cores, turnips, and other delicacies which appeal to his taste. No one should ever be allowed to tease him.

RESULTS IN FEEDING DAIRY COWS.

In feeding milch cows the Kansas Agricultural College and Experiment Station are carrying on a double mission: First, to ascertain facts and figures that will benefit the dairy farmers. This kind of experimental work is frequently expensive, as it puts the regular work at somewhat of an inconvenience, and sometimes cows are being milked at a loss in order to ascertain experimental data. The second mission is to develop common, grade and pure-bred cows to high and economical production of dairy products. Feeds are supplied to produce the largest yield at the lowest cost. To do this it is necessary to know the relative value and cost of the different feeds.

MAINTENANCE RATION. This test was made with wheat straw and ground wheat, in order to show the possibilities of utilizing these feeds during the fall and winter following the severe drought of 1901.

Three dry cows, averaging 1226 pounds live weight, two two-year-old heifers, averaging 1059 pounds, and three calves, averaging 510 pounds, were selected for this test. The experiment began August 1, when the aggregate weight of the eight head amounted to 7327 pounds, As the cows came from good sorghum pasture and the heifers and calves from good prairie pasture, they did not relish the wheat straw for the first few days, and only consumed about ten pounds daily per

head. The cattle were fed four pounds of ground wheat daily per head throughout the experiment. By dampening the straw and sprinkling the grain on and through it, considerably more straw was consumed, the average for thirty-one days being sixteen and one-half pounds daily per head.

At the close of the first week every animal in the experiment lost in weight, the average being 62 pounds per head. During the second week they regained a considerable portion of this loss. At the close of the experiment, September 1, the three cows weighed an average of 1172 pounds, a loss of 54 pounds per head for the thirty-one days under experiment; the heifers averaged 1067 pounds, a gain of 8 pounds per head, and the calves averaged 523 pounds, a gain of 13 pounds per head. The total weight of the lot at the close of the experiment was 7217 pounds, a loss of 110 pounds for the lot or 13 pounds per head; a small item when one considers that it all came in the first week of the experiment. The total feed consumed by the lot was 4232 pounds of wheat straw and 992 pounds of ground wheat, The straw was hauled about eight miles, and did not contain any chaff or refuse wheat. When the cattle have access to a straw-stack they get considerable chaff and more or less shriveled or waste wheat blown over with the chaff. Under these conditions cattle would not need as much wheat as given above.

This experiment indicates the possibilities in wintering cattle. When wheat straw, doubtless the poorest roughage on the farm, can maintain an animal with a small outlay of ground wheat, it ought to encourage a farmer to hold his cattle. Straw is abundant, especially in the western part of the state. In many places it is being burned, in order to get rid of it. Where straw can be had for the hauling, and wheat at sixty cents per bushel, the feed cost of keeping a 1000-pound cow on a maintenance ration need not exceed $1.25 per month. Suppose the straw costs $5 per ton, the feed cost would be only $2.50 per head per month, or $1.50 more than it usually costs in years when feed is plentiful. Most every farmer produces rough feed considerably better than wheat straw. Prairie hay, corn-fodder, Kafir-corn fodder, sorghum-fodder or hay can be fed, either alone or in combination with each other, and the amount of grain required for maintenance reduced. Where Red clover or alfalfa is available, little or no grain need be fed.

The present low prices of stock cattle, with every prospect of high prices in the spring, and the cheapness with which the cattle can be wintered, as shown by the above experiment, should induce farmers to hold their cattle, even though they could be sold at fair prices.

THE QUESTION OF THE BALANCED RATION. Most dairymen find that

they get the best results from their cows during the month of June, when they are pasturing on luxuriant grass. In supplying winter feed it should be the aim to get just as near June conditions as possible.

Analyses of fresh mixed pasture grasses show digestible nutrients, as follows: Protein, 2.5 per cent.; carbohydrates, 10.2; and fat, 0.5 From this it will be seen that there is a liberal supply of protein, and if we are to approximate these conditions in winter, it is necessary to furnish feeds that contain plenty of protein. Where cows have been wintered on feeds deficient in protein the milk flow is greatly stimulated and the yield is greatly increased when turned on pasture. The experience of this Station is, that when we continue to feed plenty of protein there is not this difference in turning cattle on pasture.

In a test conducted with twenty-one cows, in the spring of 1899, we found that in a lot of eleven that were turned on pasture there were seven cows that gained in the yield of milk while four lost; the average being a weekly gain of 3.6 pounds per cow. Eight cows out of eleven gained in the per cent. of butter-fat, the average being 0.18 of 1 per cent. One cow lost both in yield and in test, while three others lost in yield and gained in test. There were five cows that gained both in yield and in test. This shows that there was very little gained in total production by turning on pasture, but this is accounted for by the fact that the cows previous to being on pasture were fed liberally on a ration containing plenty of protein, At the same time that we carried on the pasture experiment a lot of ten out of the twenty-one were fed on soiling crops. These cows did not yield as well as those on pasture, as might be expected in early spring, when the grass is green and succulent. Only three cows out of ten gained in the yield of milk, the average result being a weekly loss of 4.2 pounds per cow. Seven cows gained in the per cent. of butter-fat, the average being a gain of 0.09 of 1 per cent. As in the pasture lot, one cow lost both in yield and in test, and six lost in yield but gained in test.

As far as the experience of the Station goes, when cows are kept on a liberal ration that is well balanced and approaches the conditions existing with June grass, there is very little increase in yield and practically no decrease in test due to pasture or soiling crops.

Economy of Liberal Feeding. A cow giving a large flow of milk is a hard-working animal, and needs to be fed accordingly. It is estimated that about sixty per cent. of what a cow is able to consume goes to maintain the wear and tear on her system, and the profit in milk- and butter-fat production comes from the feed she consumes outside of this amount needed for support. The cow is selfish enough

to take her share of the feed first, and then what is left over goes to the owner for his profit. If this per cent. needed for maintenance is correct, it stands to reason that a cow fed seventy per cent. of what she will eat will return ten per cent. profit; while the cow fed 100 per cent. will return forty per cent., or four times as much. Of course it is possible to overfeed, and a man should watch his feed-bin and milk-scales at the same time. If he suspects that the cow is not getting enough then he should increase the feed, and if she responds in the form of increased yield of milk perhaps the feed should be increased some more; but if she fails to respond, then withdraw the extra feed. Our experience indicates that the cows must be studied individually, and the amount of feed given them must vary according to the individual capacity. It took very little more feed for our best cows than it did for our poor cows. If we had withheld the feed from the good cows the amount realized would have been materially decreased. It does not pay to feed a poor cow, but it does pay to feed a good cow liberally.

IMPORTANCE OF RAISING DAIRY FEEDS ON THE FARM. It used to be said that a balanced ration for a dairy cow could not be produced without buying high-priced concentrates. The experience at this College proves that statement to be false. The possibility of producing a balanced ration on the farm, together with the economy of the same, is shown in the following rations:

	RATION.	Feed, lbs.	Protein.	Carbo-hydrates.	Fat.
I.	Corn-fodder	25	.50	8.30	.15
	Corn	10	.78	6.67	.43
	Totals	35	1.28	14.97	.58
	Required	.....	2.50	12.50	.40
II.	Corn-fodder	25	.50	3.30	.15
	Corn	5	.39	3.33	.21
	Bran	5	.61	1.85	.13
	Totals	35	1.50	13.48	.49
III.	Orchard-grass hay	10	.48	4.20	.14
	Clover hay	10	.68	3.54	.17
	Corn	4	.31	2.66	.17
	Bran	1	.12	.87	.02
	Chicago gluten-meal	3	.93	1.31	.14
	Totals	28	2.52	12.08	.64
IV.	Alfalfa	18	1.90	6.71	.25
	Corn	8	.62	5.33	.34
	Totals	26	2.52	12.04	.59

The experience of this Station shows that, with pasture and soiling crops, we can produce butter-fat from 6 to 9 cents per pound; with alfalfa and Kafir-corn meal we have produced butter-fat at 11.9

cents per pound; with Kafir-corn one-half, bran one-fourth, and ground oats one-fourth, and Kafir-corn stover, for 10.8 cents per pound; and with Kafir-corn meal one-half and soy-bean meal one-half, and Kafir-corn stover, for 12.3 cents per pound.

When we have had to buy high-priced concentrates it has cost fifteen, sixteen and seventeen cents per pound for butter-fat. This emphasizes the importance of raising as much of the feed as possible on the farm. Mill feeds may at times be cheap enough so that a man can afford to sell the crop from the farm and buy them. This can only be determined by taking into consideration the feeding value of each, the cost, and the expense of making the exchange.

MANAGEMENT WITH HIGH-PRICED FEEDS. When feeds are high it sets the dairyman to thinking how he can combine them in the best possible form to get the largest results from the value of the feed used. This means that the man must size up his herd and not feed the cows more high-priced feeds than the value of the products they will turn out.

Mature dry cows and those so near dry that their milk is not paying for their feed can be put on maintenance rations; *i. e.,* enough feed to keep the animal in good health and enable it to maintain its present weight without making gains. The following may serve as a guide to the amount of different feeds required per thousand pounds live weight:

1. Wheat straw 18 to 20 pounds (feed all cattle will eat), corn chop or bran 4 or 5 pounds.

2. Corn-fodder (stover) 18 to 20 pounds (feed all the cattle will eat), corn chop or bran 3 or 4 pounds. Oat straw can take the place of corn-fodder by increasing the grain allowance one-half pound.

3. Sorghum hay 20 pounds, corn chop or bran 2½ pounds. Fodder, corn and timothy hay can be used in place of sorghum hay, and the allowance of grain increased a trifle.

4. Oat hay, millet hay and orchard-grass hay will probably maintain an animal without grain. Prairie hay may require a little grain. Alfalfa and clover hay will not only maintain an animal but will enable it to grow or gain in live weight. When alfalfa forms a part of the ration with other roughage an animal can be maintained without grain.

In the above rations, corn chop and bran have been used for the grain because in many localities they are the cheapest. Where ground wheat and oats can be had at the same price they make excellent substitutes. Kafir-corn or sorghum seed can also be used, by slightly increasing the allowance.

In an ordinary herd, cows will be found that vary considerably in

their milk yield. It stands to reason that a cow giving 10 pounds of milk daily does not need the same quality and quantity of feed as a cow giving 20 or 30 pounds daily. The rations following indicate the amount needed daily per head where different amounts of milk are produced. When cottonseed-meal is used cows should be accustomed to it gradually. Allow one-half pound the first day, and increase not over one-fourth or one-fifth of a pound per day,

Cows Yielding Eleven Pounds of Milk Daily.

5. Alfalfa hay 10 pounds, corn-stover 10 pounds.

6. Corn-fodder (stover) 20 pounds, ground wheat 44 pounds, cottonseed-meal 2 pounds.

7. Corn-fodder 15 pounds, wheat straw 5 pounds, ground wheat 4 pounds, cottonseed-meal 2 pounds.

8. Sorghum hay 20 pounds, bran 3½ pounds, cottonseed-meal 2 pounds.

9. Prairie hay 20 pounds, bran 3 pounds, cottonseed-meal 1½ pounds.

Cows Yielding Sixteen Pounds of Milk

10. Alfalfa hay or soy-bean hay 10 pounds, oat hay 8 pounds, ground wheat 6 pounds.

11. Alfalfa hay 8 pounds, millet hay 12 pounds, bran 5 pounds,

12. Alfalfa hay 10 pounds, millet hay 8 pounds, ground wheat 6 pounds.

13. Sorghum hay 20 pounds, ground wheat 5 pounds, cottonseed-meal 3 pounds.

14. Prairie hay 10 pounds, corn-fodder (stover) 10 pounds, bran 7 pounds, oil-meal 2 pounds.

Cows Yielding Twenty-two Pounds of Milk.

15. Alfalfa hay 15 pounds, oat straw 5 pounds, Kafir-corn meal 8 pounds, ground wheat 1½ pounds.

16. Alfalfa hay 10 pounds, sorghum hay 8 pounds, ground barley 5 pounds, bran 7 pounds.

17. Sorghum hay 15 pounds, millet hay 5 pounds, bran 7 pounds cottonseed-meal 3 pounds.

18. Corn-fodder (stover) 10 pounds, cowpea hay 10 pounds, corn-and-cob meal 7 pounds, bran 4 pounds, soy-bean meal 1 pound.

19. Prairie hay 10 pounds, soy-bean hay 10 pounds, ground wheat 8 pounds, oil-meal 1 pound.

Cows Yielding Twenty-seven pounds of Milk.

20. Alfalfa hay 20 pounds, ground wheat 10 pounds.

21. Alfalfa hay 20 pounds, corn- or Kafir-corn meal 7½ pounds, soy-bean meal 2 pounds.

22. Alfalfa hay 15 pounds, oat hay 8 pounds, ground wheat 7 pounds, cottonseed-meal 3 pounds.

23. Sorghum hay 10 pounds, prairie hay 10 pounds, ground wheat 8 pounds, cottonseed-meal 2 pounds.

24. Millet 10 pounds, fodder corn 10 pounds, corn- or Kafir-corn meal 4 pounds, bran 5 pounds, oil-meal 3 pounds.

The above rations enable a man to choose so that, he can increase or decrease the feed in accordance with the amount of milk given by the cow. Without such knowledge, much costly feed may be wasted on cows that would not make adequate returns for it.

FEEDING ROUGHNESS.

Rough feeds, including pasture, are usually so plentiful that frequently we feed them without any idea as to what and how much will produce the desired results. Much rough feed is wasted in careless feeding. The cow will eat the best of her menu first, and if given too much will pick the most desirable morsels, leaving what might be called passably good, which too frequently is treated as waste and thrown under foot. No more hay should be given an animal than it will eat up clean. This refers to first-class quality, however, as we could not expect a cow to eat up clean a poor quality of hay. Difference in individuals will sometimes cause some cows to leave feed which others will eat, providing the roughness is in a rack or manger accessible to the whole herd. Cows can sometimes be fed too much roughness. A little experience in feeding roughness at this Station furnishes a valuable lesson.

The boys working with the dairy herd were anxious to have the cows make the best possible yields, and they were tempted to give the cows all the good alfalfa hay they would eat. When we found the alfalfa hay going very rapidly we looked for the cause, and found that the dairy cows had consumed an average of forty-three pounds per head daily, besides fifteen pounds of Kafir-corn fodder. The amount of alfalfa hay was reduced to thirty-three pounds and the Kafir-corn fodder to three and one-half pounds daily per cow, and we found that the daily yield of milk was slightly increased. The quality of the hay was the same in both instances. In the latter case it was eaten up clean, while in the former considerable was hauled away and fed to dry stock. Later records show a still greater reduction in the allowance of alfalfa without decreasing the flow of milk. This experience shows some of the leaks that may take place in feeding roughness, especially when those feeds are appetizing, like alfalfa or Red clover.

In feeding the rough feeds, the following table has been used by the Agricultural College as a guide.

TABLE XXII.—Comparative value of rough feeds.

ROUGHNESS. Value per ton, when alfalfa is worth $1 per ton.

FEEDS.	Total nutrients.	Protein nutrients.	FEEDS.	Total nutrients.	Protein nutrients.
Dry roughage:			*Green roughage:*		
Alfalfa	$1 00	$1 00	Alfalfa	34	37
Corn-fodder	32	19	Corn silage	13	12
Cowpeas	97	1 02	Fodder corn	14	09
Fodder corn	40	24	Pasture grasses	23	24
Millet	64	42	Sorghum fodder	12	06
Oat hay	59	41	Soy beans	28	30
Oat straw	33	15			
Orchard-grass	60	45	*Roots and tubers:*		
Prairie hay	51	33	Mangels	10	09
Red clover	70	64	Sugar-beets	14	10
Sorghum	43	23	Turnips	11	08
Soy beans	98	1 02			
Mixed hay	67	56			
Timothy	47	27			
Wheat straw	25	08			

For ease of calculation, the ***roughness*** figured on the basis of alfalfa hay selling for $1 per ton. When alfalfa is worth $6 per ton the other rough feeds are worth six times the amount indicated in the table; when alfalfa is worth $8 per ton the other feeds are worth eight times as much, and so on.

Usually we find that we can feed practically all the rough feedthat the cows can eat, although, as indicated above, with a good quality of alfalfa or clover hay they may eat more than they will consume at a profit. At this writing, alfalfa bay is selling in Manhattan at $7 per ton. This would make the feeding values of the other rough feeds worth seven times the amount indicated in the table. Red clover, for instance, would be worth seven times seventy cents, or $4.90 per ton; prairie hay would be worth $3.67 per ton; and millet would be worth $4.48 per ton. If the problem was to select the most economical roughness, we would select alfalfa at $7 per ton in preference to Red clover at $6 per ton or prairie hay at $4 per ton or millet at $5 per ton. Knowing the cost of these different rough feeds, and having this table before him, a feeder can tell which is the more economical feed to use. It will be noticed that the table is divided into two parts, the first part giving the value of the total nutrients and the second one the value of the protein nutrients. It frequently happens that we have plenty of carbohydrates and fat, but are lacking in protein. In this case we would consult the second column, in order to determine what feed to buy in order to furnish the protein most economically. If it is carbohydrates and fat as well as protein that is required, as was the condition in the dry year of 1901, then we should take the first column. When it is possible to get a rough feed containing a large amount of protein, we find that in feeding a liberal

allowance of roughness the grain can be reduced. Hence the importance of providing roughness rich in protein.

PASTURE. There are a large variety of grasses that furnish excellent pasture for dairy cows. The common prairie grasses seem to be especially adapted to our prairie country, and are able to withstand the effects of drought better than tame grasses, and, where a man has this prairie pasture, it is undoubtedly better for him to keep it than to attempt to plow it up and seed it to tame grass.

Where tame grasses are desired, a most excellent pasture has been obtained at this Station by seeding orchard-grass twenty pounds, English blue-grass fifteen pounds and Red clover five pounds per acre, sown broadcast or drilled both ways on the field. This mixture is more adapted to the eastern third of the state than to sections further west.

This Station has been making a test of *Bromus inermis* for pasture. Last fall several acres were seeded down to brome-grass on a field that had previously been in oats. The grass grew nicely, except where the volunteer oats came up, but fortunately the oats died out during the winter, and this spring the brome-grass came on in first-class shape, and is furnishing pasture this spring and summer for a herd of young bulls. The grass is thick and has a luxuriant growth, and during the dry spell that extended through the latter part of July, 1903, it remained green and luxuriant when other grasses were drying up. Stock seem to relish this grass; it starts early in the spring, coming on nearly a month earlier than the ordinary pasture grasses; it is also a good pasture in the late fall. As brome-grass can withstand a good deal of dry weather, it is adapted to any part of the state. When cut for hay, it is greatly relished by both horses and cattle.

Green wheat furnishes an ideal pasture for dairy cows, and when there is not much danger from the Hessian fly it may be seeded early and produce considerable pasture during the fall, and will furnish excellent feed during the spring. On account of the limited amount of land available for pasture purposes, this Station has not had a chance to make a comparative test of wheat pasture on the College farm, but the department has collected data from those who have pastured it, from which we quote the following:

Mr. F. L. Huxtable, Sedgwick county, Kansas, says: "Wheat makes one of the best kinds of pasture for dairy cows in early fall or early spring. The milk from cows on wheat pasture makes a June butter, which means that it is of the highest quality. Wheat pasture with some kind of straw or hay, and perhaps a very little grain, make an ideal ration for a dairy cow."

Mr. L. R. Sanford, Nemaha county, Kansas, writes: "My milch

cows do better on wheat pasture with a little straw than any other feed I give them during the fall and spring months. At the same time the pasturing seems to help the wheat and we get a better crop thereby."

Mr. A. B. Felton, McPherson county, Kansas, says: "Our cows give a large flow of milk and keep in a good condition with nothing but wheat pasture and straw. If the season is favorable for wheat growth they get little else from November until April, except in the coldest weather, when the ground is covered with snow or when it is muddy. If care be taken not to overpastare when turning stock on while the ground is soft and muddy, and not to pasture too late in the spring, you can get as good or better crop of wheat than when you do not pasture it."

Mr. J. W. Fields, McPherson county, Kansas, writes: "Pasturing wheat is good for the wheat itself if not carried too far. It furnishes a June quality of milk and butter, and furnishes the best kind of cow pasture."

Mr. John Bitner, Barton county, Kansas, who raises from 1200 to 1500 acres of wheat every year, and who pastures a large herd of cattle and horses on his wheat, says that he gets as good or better crops on fields that are pastured than those that are not.

Since it is good for the wheat to be pastured and is good for the cows to do the pasturing, arrangements should be made in the wheat sections to have plenty of green wheat for the cows.

Rye is nearly if not quite equal to wheat as cow pasture, and all recommendations given in favor of wheat can likewise be given for rye. This Station has pastured its dairy cows on rye with excellent results. There are some complaints to the effect that rye taints the milk, but we find that if the cows are brought in a couple of hours before milking-time and the milk aerated there is no trouble.

Dwarf Essex rape has been used at this Station both for hogs and dairy cows. Neither hogs nor cattle seem to relish it at first, but after becoming accustomed to it they eat it greedily, especially if it is not allowed to grow too rank. There is some danger of cows bloating on rape. It furthermore gives the milk a peculiar odor that is somewhat difficult to get rid of even by aerating it. Rape makes a much better hog pasture than cow pasture. When wanted for cows it is better to seed the rape with oats.

For the past three years the Kansas Experiment Station has secured excellent results from pasturing green sorghum. This feed we find ready to use when the pastures are dry, and it yields an immense amount of feed from a small area. We have realized in a dry season, when hay was high, as much as $8.20 per acre from pasturing green

sorghum one month, and have the field left to produce a second crop. Notwithstanding our success in pasturing green sorghum, we do not recommend it. There are too many cases on record of deaths caused by it (sorghum poisoning), and we do not even risk our pure-bred cattle on it. While we believe that much of the trouble from green sorghum is caused by cattle going on it with empty or partially empty stomachs, yet the man who pastures it must do so at his own risk.

PASTURING GREEN ALFALFA: During the last two years the Kansas Experiment Station has been experimenting to see what can be done in the way of pasturing alfalfa. This work has covered both fall and spring seasons.

On September 26, 1901, nineteen common cows were given all the alfalfa hay they would eat, and in the afternoon pastured on alfalfa, which was in a fine succulent condition, as a result of the September rains. They were watched carefully and left in from an hour to an hour and a half. No bad results followed. The next morning they were again fed all the alfalfa hay they would eat, but, after having had a taste of the green alfalfa, they seemed to care very little for the hay. They were turned on alfalfa pasture at 7:20 A. M. and taken out at 8:35 A. M. No sign of bloat was apparent. They were left in the dry lot with access to alfalfa hay. At 1:20 P. M. one of the smaller cows bloated. To give the matter a thorough test, the remainder of the herd was again turned on alfalfa pasture and remained there about fifty minutes, when one of the cows showed signs of bloating. Gas formed so rapidly that it was necessary to use the trocar and canula. The paunch was so full of food that very little gas could be removed with the canula. Four other cows were also bloated. Three were relieved by a gag, and one was finally relieved by the trocar and canula, although complete relief did not occur until about 7:30 P. M.

Soon after this experiment the College was presented with some sample "alfalfa bits," with the request that we make a thorough test of them. These bits consist of a small tube about three-eighths of an inch in diameter, the bore being about one-fourth inch in diameter. The center of this bit is perforated with holes a little over one-eighth inch in diameter, connecting with the bore running lengthwise of the bit. These holes are six in number and about one-half inch apart. It is claimed that these bits will prevent cows from bloating while on alfalfa. The gas formed is supposed to go to the mouth, enter the bore of the bit through the perforations, and escape from the bit on either side of the mouth. Since the bits were recommended by some of our most successful stock-breeders of the state, we thought we should give them a test.

The 1st of November we took ten calves, averaging about six

months of age, and put them on alfalfa pasture, five with bits and five without bits. These calves became accustomed to the alfalfa gradually, the time being increased fifteen minutes per day until they got all they would eat. This experiment was continued through the month of November, and we did not have asingle case of bloat, with or without the bits.

We continued the experiment with the bits during the months of May and June, 1902, using cows instead of calves. Three cows were provided with bits and one without. These cows were first allowed to eat all the tame-grass pasture they could handle, after which they were turned on alfalfa for fifteen minutes. The next day they were given the same treatment, with the exception of increasing the time on alfalfa to thirty minutes; the third day they were on for one and one-half hours; the fourth, three hours; then all day, and a little later were allowed on day and night. No case of bloat appeared for over a week. At this time the alfalfa was cut, and soon after the cows were eating second growth. One morning soon after this the cow without the bit bloated immediately after being watered; she was relieved of the gas by a gag, after which an alfalfa bit was placed in her mouth, and she was allowed to return to alfalfa pasture. For a couple of days all went well, after which she bloated up six different times, and the last time had to be punctured. One of the other cows bloated three times and another four times. One of the cows went through the experiment without bloating at all. About the middle of June a fifth cow was added to the experiment, with a bit. In less than ten days she had bloated twice.

Our experience indicates that it is unsafe to pasture alfalfa with cows, although some farmers have done it successfully, and we have done it successfully with some individual animals. If a man wants to run the risk of pasturing alfalfa, we believe the bits are a help, in that they prevent the cows from eating the alfalfa as fast as they would without them. The bits might have some influence as a gag, although they appear to be rather small for this purpose and have a tendency to make the cow's mouth sore. Our experience indicates that the openings into the bore of the bit are of no particular value, as they are soon stopped up with the green alfalfa. The straight bits seem to be better than the curved ones, as they are more easily cleaned.

The cows did well while on alfalfa, they increased in the milk flow, and not only did not need grain but would practically refuse to eat it; but they required so much watching, especially with the second growth of alfalfa, that we considered it too risky to keep them on it longer.

SOILING CROPS. The Kansas Station has had some experience in

feeding green feeds to cows as soiling crops. In the spring of 1899 the common herd at the Agricultural College was divided into two lots, each lot giving practically the same amount of milk, at very nearly the same test and lactation period. Each cow was given what grain she would eat at a profit, the average being a little over three pounds daily per head. The green feeds used were alfalfa, oats, corn, and Kafir-corn. The pasture was composed of both prairie and tame grasses. It should be noted in this comparison that the timely rains made the year 1899 an exceptionally good year for pasture. During the months from May to August the prices of butter-fat ranged from 14 to 15½ cents per pound, and during the month of September raised to 17½ cents. The results obtained with each of the soiling crops, together with a comparison of soiling *vs.* pasture, are given in the following table:

TABLE XXIII.—Results in pasturing and soiling dairy cows.

Kind of green feed.	No. of days fed.....	Amount eaten, lbs....	Area, acres.....	Grain.		Yield of milk, lbs....	Butter-fat produced, lbs.....	Value of product.			Income, less cost of grain.	
				Amt. fed, lbs.	Cost.....			Butter-fat....	Skim-milk....	Total.....	Per ton of soiling crop	Per acre.....
Alfalfa	74	77,145	2.97	1,623	$10 65	12,261	478.3	$69 16	$16 53	$85 69	$1 95	$25 26
Oats.....	9	12,225	1.53	128	89	1,600	61.4	9 16	2 16	11 32	1 70	6 81
Corn. ...	31	38,685	1.22	1,143	6 36	3,978	152.6	23 65	5 37	29 02	1 44	22 79
Sorghum..	15½	22,370	.67	687	4 03	1,633	70.2	12 28	2 20	14 48	93	15 60
Kafir-corn,	14½	17,550	.72	699	4 11	1,585	68.2	11 93	2 14	14 07	1 13	13 83
Totals..	144	167,985	7.11	4,280	$26 04	21,057	830.7	$126 18	$28 40	$154 58	$1 53	$18 08
Pasturing Experiment—Eleven Cows.												
Pasture....	144	.....	39.99	5,512	$33 92	27,675	1,110.2	$165 85	$37 44	$203 29	.....	$4 23

From this table we find that it requires an average of 116 pounds of green feed per cow per day, including what little was left as waste. It required 0.71 of an acre to support a cow on soiling crops 144 days. During the same period it required 3.63 acres to keep a cow on pasture. It will be noticed that alfalfa was fed 74 days. This was from May 10 until August 1, except nine days the fore part of June, when the oats were fed. Where alfalfa is properly managed it can be made to produce green feed during the whole summer. The corn was fed during the month of August. Cane was fed the first half of September, and Kafir-corn the last half.

The pasture cows yielded the most milk by 6618 pounds, and the most butter-fat by 280 pounds, but consumed 1232 pounds more grain. In the columns headed "Income less cost of grain" it will be seen that the soiling crops brought an income above the cost of grain

of $18.08 per acre, while the pasture brought only $4.23 per acre. Of the soiling crops, alfalfa gave the largest returns per acre, corn next, cane third, Kafir-corn fourth, and oats fifth. The average result shows that it is possible to get over four times as much per acre by soiling as by pasturing. This does not mean that soiling always pays, It will depend largely upon the cost of labor and the amount of pasture land a person may have. Not considering the amount of land used, our cows did the best on pasture.

During the month of June, 1900, which was one of the dryest Junes in many years at this Station the pastures became almost worthless, especially during the latter part of the month. On June 23 we began feeding the cows green alfalfa in the yards at night. On this date the milk yield for 22 cows was 395 pounds. On July 3, ten days later, the yield of these cows was 356.9 pounds; July 13, 360.9 pounds; and July 23, just as the pastures were beginning to recover from the effects of the dry spell, the yield was 446.2 pounds, No fresh cows were added during this period. The average for the entire period was 390.9 pounds — 4.1 pounds less than was given at the beginning, making a loss of about one per cent.

A milk hauler who was delivering milk to the Manhattan creamery at this time estimated that the decrease in the milk yield of the different herds from which he was hauling was about twenty-five per cent. This difference of twenty-four per cent. between the College common herd and the herds in the surrounding community is a loss not only for the entire period of drought, but in many cases a loss for the entire lactation period, and this loss was intensified by the fact that the price of butter-fat took a sudden jump in value.

Nearly every dairyman has experienced the shrinkage that comes in midsummer, when the pastures dry up and grass is scarce. It is at this time that soiling will pay and pay liberally. In what better way can a person realize from twenty-three dollars to twenty-five dollars per acre for his green corn or green alfalfa? When the cows look over the fence with longing eyes at the corn, the efforts usually spent keeping the cows out of the corn had better be spent in throwing the corn over to the cows. The green corn, alfalfa or cane growing alongside the pasture will pay greater profits if marketed to cows in need of extra feed than if held and sold to the local grain dealer; and not only that, but it will keep up the flow of milk and will increase the profits derived from dairying on dry feed next fall and winter.

The acreage required in soiling crops is comparatively small in the experiment detailed above. The acreage required per cow is only one-fifth the amount required for pasture. There are some objec-

tions to the soiling practice — it takes a great deal of labor and breaks into the other work practically every day. After heavy rains it is practically impossible to get into the field to cut the soiling crops. There is less difficulty on this score on a good alfalfa field than there is with the other crops that are usually employed for soiling purposes. On account of the difficulties involved in harvesting soiling crops, the silo is to be recommended as furnishing an excellent means of providing good succulent feed to tide over dry spells in summer. The convenience of the silo and the value of the ensilage is given later.

For the benefit of those who do not have silos and must rely upon soiling crops, the following dates are given showing the time when the different crops are available as green feeds under the conditions usually existing in Riley county:

Alfalfa, May 20 to September 30.
Wheat, June 1 to June 15.
Oats, June 15 to June 30.
Sweet corn, July 15 to July 31.
Field corn, August 1 to September 15.
Sorghum, August 1 to September 30.
Kafir-corn, August 1 to September 30.
Wheat and rye pasture, until the ground freezes.

ENSILAGE. Ensilage is any green feed preserved in an air-tight receptacle, usually called a silo. Most any feed can be used for this purpose, but usually a large-growing variety of corn, seeded rather thickly and having a large number of small ears, is used for this purpose. The principle in curing ensilage is the same as with canned fruits — to preserve the product in just as near nature's state as possible. When preserved in this manner, it furnishes succulence and variety as well as a large amount of nutrients, and green feed preserved in this manner is greatly relished by stock during winter months, when they have access to no other green feed.

Ensilage furnishes an excellent substitute for soiling crops, and the silo can be opened when the pastures are getting dry, and the flow of milk kept up by this means. When the rains come on and the pastures improve, the silo can be closed and reserved until the next time it is needed. It is easy to handle, and can be kept, when desired, for years. It can be confined in a small space, and thus save much room. It takes the place of roots, and can be produced at about one-half the cost. Where a corn-harvester is used, the cost of filling a silo has been reduced as low as thirty-three cents per ton for labor, The machinery used in filling the silo can be used to excellent advantage in preparing rough feed for cattle. As indicated below, there

is considerable saving of rough feed by running it through an ensilage-cutter.

Corn Ensilage. This Station has been using the silo for a number of gears. When this College had a large herd of Short-horn cattle, they were fed through the winter with practically no grain, receiving corn ensilage and now and then a little hay for roughness. The cattle came through in most excellent shape.

This Station has also just completed a very interesting test of corn silage for steers, and, as not unfrequently the milkers of dairy cows are also feeders of beef steers, a brief statement of our experience with ensilage for these is given herewith.

Chopped alfalfa, with a grain ration of corn and Kafir-corn, was fed with this ensilage. The lot compared with this was fed the same with the exception of the ensilage,

The steers with ensilage consumed 715 pounds of grain per 100 pounds gain, and those without ensilage consumed 733 pounds of grain per 100 pounds gain. The steers with ensilage were in a healthier condition and they finished off much better than those without ensilage, as is shown by the fact that they brought $4.95 per 100 pounds while the same class of steers without ensilage brought only $4.70 per 100 pounds. Figuring the value of the gains, and deducting the value of the grain and alfalfa fed, we find that the ensilage brought an income of $3.29 per ton.

Ensilage has also been found to be a good feed, when given in limited quantities, to hogs and even chickens.

Average farm land in an average season will produce from twelve to fifteen tons of green corn per acre, and good bottom land much more. If it only yields ten tons per acre, and is worth as much as indicated by the steer experiment, there would be an income of $32.90 per acre. Since ensilage is very desirable for both dairy cows and feeding steers and as an economical factor in hog and chicken production, and as the machinery used in connection with the silo is needed for other purposes, the silo would appear to be a very economical feature in successful farming.

Alfalfa Ensilage. The Kansas Experiment Station started an interesting experiment in the spring of 1903 to determine the possibility of converting the first cutting of alfalfa into an ensilage crop. On account of the heavy rains, it was impossible to get on the fields to cut this crop of alfalfa until June 8. The alfalfa had gone too long, and consequently was rather coarse, was rusted badly, and unfortunately had a good many weeds *(Leptilon canadense)* in it, commonly called Canada fleabane or horseweed, and would have made very poor hay. We put the entire first crop — sixty-one tons, green

weight — into the silo. This silo was opened July 16. The top two feet were molded rather badly, but after this was taken off it was found to be in excellent shape, except around the sides, where it had molded a little. When putting this ensilage into the silo, we kept one man busy tramping around the sides and distributing the ensilage evenly in the silo. Judging from the way the alfalfa molded, we ought to have had two men in the silo instead of one, in order to thoroughly pack the outside layer. Both the moldy and slightly molded ensilage around the sides were eaten up clean by the herd when hauled out into the pasture. The dairy cows ate this ensilage exceedingly well. At least two-thirds of them ate it weeds and all, and the other one-third ate it all but the weeds. We were able to keep up the flow of milk during the dry spell in the latter part of July, 1903, by feeding this alfalfa ensilage. As it comes out of the silo the ensilage does not seem to be as sour as corn ensilage, and if it is left exposed it, has a tendency to dry instead of spoiling, and we can take it out less rapidly than we can corn ensilage. We have had little experience with this alfalfa ensilage, but, so far as this experience goes, it is certainly a very desirable feed, and as the first cutting of alfalfa frequently comes at a season of the year when it is difficult to cure, as it is ranker and coarser than subsequent cuttings, it would appear that putting the first crop in the silo has many advantages.

A good substitute for ensilage is roots. Mangel-wurzels are probably the best variety, and are greatly relished by stock, are appetizing, and cause the animals to eat more of other feed. They are rather costly, however, requiring nearly twice as much expense in raising them as in producing ensilage. Where one is forcing a dairy cow to make a high record they are very desirable, and under such circumstances may be used in connection with ensilage.

ALFALFA HAY. This station has had such excellent results from feeding alfalfa hay that we consider it an indispensable factor in dairying. Usually the rough feeds are rather poor in protein, but alfalfa contains eleven pounds of digestible protein in every 100 pounds of hay. This per cent. of protein is for average hay; good quality, well cured, with the leaves on, will test much better than this. Recently the department sent samples of alfalfa hay from Riley county to be analyzed, with a view of it being used at the St. Louis test of dairy cattle. The analyses of this hay, which were common samples, showed that the total protein contained was 19.1 per cent., or 4.8 per cent, higher than the average. Our experience indicates that to a certain extent alfalfa can be made to take the place of bran; the analyses of digestible nutrients of these two feeds follow.

TABLE XXIV.—Composition of alfalfa and bran compared. (Henry.)

NAME.	Protein.	Carbohydrates.	Fat.
Alfalfa	11.0	39.6	1.2
Bran	12.2	39.2	2.7

As far as analysis of digestible nutrients is concerned, the alfalfa is fully as good as bran in carbohydrates, is nearly equal to it in protein, but falls a little behind in fat. There is doubtless greater range of variation with alfalfa than with bran, and with good quality of alfalfa the digestible nutrients will undoubtedly equal or be superior to bran,

During the winter of 1902–'03 this Station tried running the hay through an ensilage cutter, and we found that there was a great saving of feed where the hay was thus treated. When our cows were fed the whole hay there was plenty left for bedding; when they were fed the chopped hay they ate it stems and all. From our experience with feeding chopped alfalfa to dairy cows and to steers, we have estimated that there is a saving of thirty per cent. where the alfalfa is cut up.

A comparison between alfalfa hay and soy-bean hay was made with dairy cows, and it was found that soy-bean hay was not equal to alfalfa — the leaves were broken off and there were many coarse sterns which the cows did not relish. However, when the soy-bean hay was placed in the racks in the yards the cows would pick at it, and evidently received a good deal of good from it.

The same experience was realized in attempting to feed cowpea hay, here the stems being still coarser. At the time of harvesting the cowpea stems are very full of water, and it is difficult to cure them, This would frequently injure the leaves, so as to materially decrease the value of the hay. As far as our experience goes, the cowpeas furnish a better soiling or ensilage crop than they do a hay crop. The composition of soy-bean and cowpea hay approaches very closely to that of alfalfa, but on account of the physical condition of these hays they are less valuable for cattle feeding.

The Kansas Experiment Station has still further tested the feeding value of alfalfa for wintering cows not in milk. Seven head were fed entirely on this hay, commencing September, 1901, and continuing through the entire winter. The results obtained with these cows, which varied more or less in weight and age, are shown in the following table.

TABLE XXV.—Results in wintering cows entirely on alfalfa hay.

NAME OF COW.	Breed.	Age.		Wt. Sept. 2, 1901.	Wt. April 4, 1902.	Total gain, 213 days.	Daily gain.
		Yrs.	Mos.				
				lbs.	*lbs.*	*lbs.*	*lbs.*
Mary	Short-horn	2	7	1,000	1,330	330	1.54
Agistha	Hereford	1	10	840	1,111	271	1.27
College Gerben	Holstein	2	6	980	1,268	288	1.35
College Mechthilde	Holstein	2	6	950	1,238	288	1.35
Buttercup	Red Polled	1	5	450	701	251	1.18
Sunset	Galloway	1	10	651	810	159	1.06
Velvet	Galloway	1	10	829	1,039	210	1.40

The cattle gradually improved in their appearance when fed alfalfa hay.

RED CLOVER. Riley county is practically outside of the clover section, and we have had very little experience in feeding Red clover, except as we have had it in our pastures for a short time. What little experience we have had indicates that it is a feed greatly relished by cows, and that it keeps up the flow of milk next to alfalfa. This experience coincides very closely with the composition of these feeds.

SORGHUM. Sorghum is a heavy yielder and furnishes probably more succulence than any other dry feed that we have. Cattle will eat the saccharine varieties, stalks and all, with but very little waste. Our experience teaches us that it is necessary to add other feeds rich in protein. When sorghum hay is fed alone or in connection with Corn there is liable to be a lessening of the milk yield, for the reason that the cow does not get enough protein to give the best results. The difference in the composition of sorghum, as compared with alfalfa, is shown in table XXVI.

TABLE XXVI.—Analyses of alfalfa and sorghum compared.

NAME.	Protein.	Carbo-hydrates.	Fat.
Alfalfa	11.0	39.6	1.2
Sorghum	2.4	40.6	1.2

We can see from this that sorghum ID greatly deficient in protein This should be supplied in some way when feeding it.

During the past winter we have experimented with running the sorghum through the ensilage-cutter, and we find that the cows eat it up cleaner and give better results than when fed whole. When cutting up sorghum only small quantities can be stored at once, for the reason that it will heat and spoil.

STOVER FROM CORN AND KAFIR-CORN. As corn is one of our greatest crops, and will doubtless continue to be, it is very important to be able to utilize the fodder. Where there is young stock to "rough

through the winter," our experience indicates that the problem is a comparatively easy one; even milch cows on alfalfa or clover will eat a little stover when it is placed in a rack where they can get it at will. If stover is used for the sole roughness, it will require considerably more grain than with the roughness containing more protein. We have tested both the corn and Kafir-corn stover and find them to be of about equal value. Stover will be eaten up much cleaner when it is run through an ensilage-cutter than when it is fed whole.

MILLET. When cut while the seed is in a hard-dough state millet makes excellent hay for dairy cows. Millet is a fair yielder, contains a large amount of nutrients, although these are rather deficient in protein, and for this reason should be fed in connection with feeds that contain a large per cent. of this important ingredient. If the seed is allowed to ripen, we find it does not give nearly so good results for hay.

HAY FROM PRAIRIE GRASSES. We have fed prairie hay at this Station only a short time. While it may be classed as an ideal roughness for horses, it is not nearly so well adapted to cows. If grains rich in protein are fed with it, it may give fair results. On the Manhattan market prairie hay has been selling for practically the same as alfalfa, and as it is only about one-half as nutritious as alfalfa, it is usually ruled out of consideration as a roughness for dairy cows.

ORCHARD-GRASS, ENGLISH BLUE-GRASS, AND RED CLOVER. This mixture has produced an excellent hay crop which is greatly relished by the cows and gives good results. The more clover it contains the better the feed. Orchard-grass has practically the same composition as millet, and can be fed in its stead.

FEEDING GRAIN.

From tests made at this Station, we find that dry milch cows and dairy stock need no grain when supplied with nitrogenous roughness. When the cow freshens her system is taxed to its utmost to produce milk, and it requires just as much energy to produce milk as it does to pull a dray wagon, and, on account of this taxation of the cow's system, it is necessary that she be supplied with more concentrated feed, so there will be more energy given off from the same weight of feed consumed than in the case of roughness. There is a limit to the bulk that it is possible for a cow to consume, and if she has consumed about as much bulk as she can handle before calving, the increased energy must come from the more concetrated feed. The amount of grain that is to be supplied depends upon the amount of work that is to be done. It likewise depends upon the richness of

the roughness that is fed with it. There is much greater variation, due to the individuality of the cow, that is to be considered in feeding grain than in feeding roughness. The idea should be to get each cow to eat what grain she will handle at a profit. As an aid to determining the most economical grain, this Station has been using the figures recorded below.

TABLE XXVII.—Comparative value of grains and by-products.

GRAINS AND BY-PRODUCTS: Value per 100 pounds when corn is worth 10 cents per 100.

FEED.	Total nutrients.	Protein nutrients.	FEED.	Total nutrients.	Protein nutrients.
Concentrates.			*Concentrates.*		
Barley	$0.10	$0.11	Rye	$0.11	$0.12
Broom-corn seed	.08	.09	Sorghum seed	.08	.09
Corn	.10	.10	Soy-bean meal	.23	.38
Corn-and-cob meal	.07	.08	Wheat	.11	.13
Cow peas	.15	.23	Wheat bran	.10	.16
Cottonseed hulls	.02	.003	Wheat middlings	.12	.16
Cottonseed-meal	.28	.47	Wheat shorts	.11	.15
Flaxseed	.18	.26			
Chicago gluten-meal	.21	.40	*Milk.*		
Kafir-corn seed	.09	.10	Whole milk	.03	.04
Linseed-meal	.22	.37	Skim-milk	.02	.05
Millet seed	.09	.11	Whey	.008	.01
Oats	.09	.12	Buttermilk	.03	.05

This table is constructed in the same manner as the table for roughness, taking corn at ten cents per 100 pounds as the basis. This table is also arranged on the basis of total nutrients and protein nutrients. After the cheapest grain ration is selected, and getting the test of the cows by matching the milk record, the amount fed can be increased or decreased according to the ability of the individual cow to consume it at a profit. The experience of the Kansas Experiment Station shows that one cow will produce butter-fat at 10.11 cents per pound for feed consumed and another by her side will charge twenty-four cents per pound. This difference would never have been found out if we had not kept records as to the amount of milk produced and feed consumed.

It is usually desirable to feed two or three pounds of grain per head daily to milch cows during the summer. For the best cows, the allowance may be increased to six or eight pounds. As the cows get considerably more protein out of fresh green hay than they do out of cured hay, their grain ration may be more carbonaceous for summer than for winter, Corn-and-cob meal will answer very well. If the meal is used without the cob, it is well to distend it with a little bran. The value of this extra summer feed was tested by this Station in the summer of 1898.

The College herd consisted of thirty common cows that were fed an average feed of three pounds per day per head. These cows were

compared with fifty-five cows of the same class belonging to eight different patrons of the Manhattan creamery, and which had received no extra feed in addition to pasture. On July 5 the College cows were yielding an average of 18.42 pounds of milk per day per head, while the patrons' cows were yielding 12.67 pounds per head. On August 16, six weeks later, the College cows were yielding 17.59 pounds per head, while the patrons' cows were yielding 7.71 pounds per head. This makes a drop of 0.83 of a pound per head per day — 4½ per cent. — for the College cows, and 4.96 pounds per head per day — 39 per cent. — for the patrons' cows. The feeding of a little extra grain has much to do with keeping up the flow of milk during the critical period of dry weather, and adds materially to the profits that occur after the dry weather is past.

Following the dry season of 1901, the high prices prevailing for grain caused a good many dairymen to dry up their cows and feed them on rough feed. This Station inaugurated an experiment to determine whether this policy would pay or not. It required so much feed to maintain the animal, and the question to determine was, how much more fed would it take above the feed of maintenance to obtain a good flow of milk.

Three cows, representing a fair average of our Kansas milch cows, were fed wheat straw, ground wheat, and cottonseed-meal. The cows became accustomed to the cottonseed-meal gradually, by starting with one-half pound, and increasing one-fourth pound daily until the maximum of 4 pounds per day was reached. This transition period required fourteen days. As these cows had been receiving sorghum pasture and alfalfa hay, they did not relish the straw at first, and were allowed 52 pounds of alfalfa hay during the transition period. The following figures give the results in the production of butter-fat:

Daily production of butter-fat per cow previous to experiment, thirty days, 0.74 pound.

Daily production of butter-fat per cow during transition period, fourteen days, 0.70 pound.

Daily production of butter-fat per cow during experiment, thirty days, 0.62 pound.

The reduction of 0.1 pound in the daily production of butter-fat is accounted for in the sudden change from succulent pasture to dry straw and the increase in the lactation period. After the cows were accustomed to the change, the production of milk and butter-fat was fairly uniform.

During the thirty days under experiment these three cows consumed:

Wheat straw	1,410	pounds.
Ground wheat	590	"
Cottonseed-meal	244.5	"

According to experiment reported under "Maintenance Ration," these cows would consume as much or more straw and 360 pounds of wheat of the above grain as a maintenance ration. This leaves 230 pounds of ground wheat and 244.5 pounds of cottonseed-meal to be oharged against the butter-fat account. At $1 per 100 pounds for wheat and $1.50 per 100 for cottonseed-meal, this would amount to $5.96. During this time these three cows produced 56.2 pounds of butter-fat. At 17 cents per pound, the financial statement stands as follows:

Value of 56.2 pounds of butter-fat	$9 55
Cost of feed	5 96
Total profit	$3 59
Profit per cow	1 19

In the above account the skim-milk is to pay for the hauling. With good management it will do more than this.

It will be noticed that this experiment represents an extreme case, Nearly every farmer has some corn or Kafir-corn fodder, millet, sorghum hay, prairie hay, Red clover, alfalfa, oat hay or even oat straw that can be used instead or in place of part of the wheat straw with much better results. Any of these rough feeds will 'enable the dairyman to reduce the amount of grain needed. Where Red clover or alfalfa is available, little or no cottonseed-meal is required.

By feeding his milch cows on a milch ration, the farmer will not only save more money than he would to winter them on a maintenance ration, but he will keep his cows in the habit of giving milk (a very important point), will help to keep his creamery, skimming station or cheese factory operating on a paying basis, and will have his cows on hand as a paying investment in the spring. If he then desires, he can dispose of any of his surplus stock at high prices.

CORN. This grain makes an excellent balanced ration in connection with alfalfa, This Station fed alfalfa and corn as the dairy ration for a considerable length of time, and it was found to give excellent results. Corn is appetizing and is relished by the cows.

KAFIR-CORN. We have fed Kafir-corn in comparison with corn, and find that we can get very nearly as good results with it as with corn, and we have used it in the place of corn in figuring out balanced rations. When it comes to yield, the Kafir-corn has the advantage of corn. Eleven years' experience on an upland farm belonging to the

Kansas Agricultural College shows that the average yield of corn has been 34.5 bushels per acre, while the average yield of Kafir-corn has been 46 bushels. Wherever we have fed corn and Kafir-corn mixed we have obtained better results than with either one alone.

Some complaints have reached this Station of the poor flavor Kafir-com gives to butter when fed to dairy cows. The Kansas Station has fed the grain and fodder of Kafir-corn for months at a time, and has never experienced a particle of trouble in its producing a poor quality of butter. During the months of February and March, 1898, the Station herd was fed almost exclusively on Kafir-corn meal for a grain ration. At that time the dairy school was in session, and we were making butter from the milk of this herd without the addition of any milk from outside sources. The butter was tested by competent judges and pronounced excellent in quality. Since then the grain and fodder of Kafir-corn have been fed as the whole or part of the ration for our dairy cows, and the milk from these cows has been used as starter for ripening cream, and in no instance have we heard a single complaint from the use of College milk on account of the Kafir-corn flavor. We have noticed that when the season is poor for growing fodder considerable penetrating dust arises from the crop when handled at feeding-time. If the feeding is done just before or at milking-time, particles of this dust with the germs they carry will undoubtedly find their way to the milk-pail, and will undoubtedly cause a poor quality of butter. Usually the complaints have come where the Kafir-corn is more or less damaged by rains, and where the feed was damaged the most the milk made the poorest quality of butter, and indications pointed to a slight decomposition of the feed. As hays and fodders of all kinds contain a large number of offensive germs, every effort should be made to prevent their entrance into the milk.

GROUND WHEAT. When corn is high wheat may be used as an economical feed for dairy cows. We have fed it in the place of corn and bran and obtained fully as good results from its use.

BRAN. Bran is frequently cheaper than corn, considering the amount of nutrients it contains, and is an admirable cow feed. This Station has fed it at times as the sole grain ration, and at other times as one of the main components of a grain mixture, where other grains can be had at reasonable prices. We prefer using it in a mixture, and only when other grains are high in comparison do we use it as the sole grain.

SOY BEANS. The soy bean is a plant imported from Japan, and the grain from this plant is noted for its high content of protein and oil.

It compares very favorably with oil-meal in composition, as will be seen from table XXVIII.

TABLE XXVIII.—Soy beans and linseed-meal compared as to digestible nutrients.

NAME.	Protein.	Carbo-hydrates.	Fat.
Soy beans	29.6	22.3	14.4
Oil-meal	28.3	32.7	7.0

Experiments at this Station shown that in most cases soy beans can be made to take the place of oil-meal as a feed for dairy cows. During the summer of 1899 soy beans were raised on the College farm in considerable quantities and were produced at a cost of eighteen dollars per ton. During the following fall oil-meal was sold at twenty-eight dollars per ton. This makes a saving of ten dollars per ton to the farmer who grows his own oil-meal equivalent on the farm. Soy beans are not very heavy yielders. Twelve to fifteen bushels per acre is a fair yield, and it is a question as to whether it will pay to grow them extensively in the alfalfa and clover districts, for the reason that protein can be furnished in these plants in much larger quantities and much cheaper per acre of land employed.

Soy beans have the quality of producing softness in butter. An experiment was made at this Station by making soy beans one-half of the grain-ration for the dairy cows, and the butter became so soft that it was impossible to work it satisfactorily after it was churned. Even though it was chilled with ice-water, it was impossible to mix the salt with the butter without having large and numerous streaks through it. This difficulty is not experienced when soy beans form only a small part of the ration, and, as they are very rich, a small quantity is usually sufficient to furnish the nutrients required by the cow.

COTTONSEED-MEAL. The College dairy herd has been fed cottonseed-meal rather extensively, but rather cautiously, with excellent results. In feeding it we have been careful to get the cows used to it very gradually, beginning with not over one-fourth to one-half pound daily per head. This allowance was gradually increased until the corns were consuming from three to five pounds daily per head. The cottonseed-meal had the opposite effect from the soy-bean meal: it hardened the butter, and in the winter-time had a tendency to make it crumble. With soy beans and cottonseed-meal available, it is possible forthe private dairyman to so regulate the ration of his cows that he can produce butter of any desirable consistency.

CONDIMENTAL STOCK FOODS. The Kansas Station has made a careful trial of the Acme stock food, and the Globe stock food as

feeds for dairy cows. The details of this experiment were published in Press Bulletin No. 88. A summary of the results indicates that these stock foods are of no special value to dairy cows accustomed to a good balanced ration. This experiment has been verified by the experiments of other stations, which have tested even larger numbers of stock foods. With financial gain as his object, it will pay the dairy farmer to confine himself to those feeds that have been thoroughly tested and whose merits are known, rather than to pay exorbitant prices for feeds which are, to say the least, of doubtful utility. The cows used in this test were in good health, and we had no chance to test the tonic effect on cows that were not in the best of condition.

IMPROVEMENT OF FEEDS FOR DAIRY COWS.

In the rations and tables that have been presented in this bulletin only average yields and composition have been given. No enterprising dairyman can be satisfied with averages. He will endeavor to cure his hays in the best possible condition. Alfalfa, for instance, that has been exposed to the rain loses almost one-half of its feeding value. Its composition also varies at the time of cutting. The largest amount of nutrients are found in the crop when it is cut about the time that one-tenth of the plants are in bloom, and what applies to alfalfa applies in the same manner to other forage crops. Considerable interest is being manifested of late in improving the feeding qualities of the different feeding stuffs by selection and breeding the plants. Much has already been done along this line, and undoubtedly a great deal more is to follow. Much good will come from watching these experiments along the line of improvement, and by applying this it is possible materially to increase the quality of our different feeds. This means that we will get more out of 100 pounds of feed, and the enterprising dairymen will study these problems so as to realize as much as possible by this means, and will always be ready to make use of new discoveries as soon as they are known.

DIGESTIBILITY OF MILK.

Some interesting experiments have been carried on at the Kansas Experiment Station in testing the digestibility of milk. Physicians tell us that milk must be coagulated in the stomach before it can be digested. The principle that coagulates milk is rennet. About one quart of milk was taken from each of several cows, and to each quart was added 1c. c. of rennet extract. The time that it took these various samples of milk to coagulate was noted, and it was found that the milk from one cow would coagulate much quicker and in better shape than another. For instance, the milk of Zacona (No. 20), the best butter cow in the herd (bringing an income of $70 to $75 per year

for dairy products, not including the calf), was almost impossible to coagulate, and when it did coagulate it was stringy, and not a nice, clean curd. The milk of the next best cow, on the other hand, coagulated quickly and in first-class shape. The other cows fluctuated between these two, some coagulating readily and others with great difficulty

If it is true that the milk must be coagulated before it is digested, and the milk of some cows coagulates with great difficulty or not at all, it stands to reason that an infant or an invalid might starve on the milk of some cows and no one would know the reason why. In delivering milk to cities milkmen are frequently asked to bring the milk from the same cow each day for infants or invalids. If the cow happens to be one like the best butter cow of the College herd, it might be very disastrous to the infant or invalid using the milk. Without a digestibility test it would be much better to use the milk of a mixed herd than from any one cow.

In carrying on tests to determine the ease with which the milk from different cows coagulated with rennet, we found one pure-bred Ayrshire cow (Maggie of Woodroffe) whose milk would not coagulate at all with the ordinary amount of rennet, and it coagulated with exceeding difficulty with a large amount of rennet, and when it did coagulate it was not a normal coagulation. The Station tested the feeding of this milk to a half-Guernsey steer calf. This calf was gradually changed from skim-milk to the whole milk from Maggie of Woodroffe. As soon as it had received as high as five pounds of this milk it was found to be scouring very freely, and seemed quite sick. As soon as this was discovered the milk from Maggie of Woodroffe was taken away from the calf. In three days he had recovered, and we again put him on the milk of Maggie of Woodroffe. He showed no signs of scouring for two weeks, when for several days he either refused to eat his grain or ate it very sparingly. Two days after the second siege of scouring he was changed to the milk of a pure-bred Guernsey cow (Countess Vesta) which coagulated very readily with rennet. The calf grew better at once and ate grain heartily. The milk from Countess Vesta was continued for two weeks, during which time the calf gained nine pounds the first week and twelve pounds the second week. At this time the calf was changed again to the milk of Maggie of Woodroffe, but this time it did not seem to affect him. The first week after this last change he gained thirteen pounds, and the second week he gained thirteen pounds, and appeared hearty and vigorous.

WATER FOR DAIRY COWS.

Observations of the College dairy herd show that the cows appreciate cool water in summer, and water from which the chill has been removed in winter. Cows will frequently take a drink where the water enters the trough, thus getting it fresh and cool; in the winter-time they are noticed to drink near the tank-heater, where the water is warm. As milk is composed of eighty-seven per cent, water, it is desirable that the cows be given all of this ingredient they need, and it should be given in such form and at such times that it will enable them to have all that they need, and have it in the best possible condition for obtaining a good milk yield.

In the creamery patrons' investigation referred to in the early part of this bulletin, there were eighteen patrons, twenty-two per cent. out of the eighty-two patrons, that compelled their cows to drink ice-water from a creek or pond in winter. Experience tells us that the dairy Cow will not do her best when the water is so cold that it makes her teeth chatter to drink it; furthermore, our experience tells us that it is no more work to keep tank-heaters running in water than it is to break the ice.

This Station has been using several makes of heaters in the cow-yard and feed-lots, and we give herewith our experience in running these heaters from December 2, 1900, until April 1, 1901, as given in table XXIX.

TABLE XXIX.—Experience with tank-heaters.

NAME.	MANUFACTURER.	Time fired, days.	Coal, total pounds.	Pounds used daily.
United States...	U. S. Wind Engine and Power Company, Batavia, Ill	119	1,869	15.7
United States...	U. S. Wind Engine and Power Company, Batavia, Ill	119	1,933	16.2
Butler	Butler Company, Butler, Ind	119	1,894	15.9
"	" " " "	119	1,538	12.9
Goshen	Kelly Foundry and Machine Company, Goshen, Ind.	119	2,180	18.3
Champaign	H. Reynolds, Gifford, Ill	111	940	8.46

Total coal consumed by heaters	10,354	lbs.
Average per heater	1,725.6	"
Average consumption of coal per heater per day	14.66	"
Total cost of coal	$20 70	
Average cost per heater	3 45	
Average cost of coal per heater per day	029	

Water exposed to the hot sun in summer is not very inviting to the sensitive dairy cow. In providing water it is well to consult one's own feelings, and provide such as one would be willing to drink himself. This would induce a man not to give his cows water from stagnant ponds, where a vast amount of impure matter comes from the drainage of land which is covered with decomposing matter, and brings to their cows an unaccountable number of various injurious

germs. Such mater is not fit to smell, much less to taste or drink, If it is necessary to have cows get water from a pond, it should be drawn off through the means of a pipe to a distance far enough to keep the cattle from standing in it and making it muddy and disagreeable.

COMFORT OF THE COW.

The nervous system of the cow is in close connection with the milk-secreting system, and we find that in order to get the best results the cow must be surrounded with such conditions as will appeal to her maternal instinct. This is helped by providing plenty of ventilation and sunlight, and it is also helped by keeping cows out of dark basements, where dust accumulates and germs thrive.

SHADE. During the summer of 1899 provision was made for a wood-lot into which our cattle could run when on a hill pasture. It was noticed that the cows ignored the efforts that we put forward to provide them shade in a ravine near by and went to the top of a hill instead. The stiff breezes usually found on this high space had the effect of driving away many of the flies, and left the cows free to manufacture pasture grass into milk. Where it is possible to provide a place of this kind with shade-trees it would make an ideal summer resort for the dairy cow, for which she would express her thanks in the form of an increased yield of butter-fat.

SCRATCHING-POLES. We have also found it advisable to have scratching-poles in the yard. One end of a long pole can be set in the ground and the other fastened to an upright post. The pole will thus form an incline with the surface of the ground and will present various heights, so that any sized cow can get under and scratch herself. Our stock patronize these scratching-poles quite extensively. The dairy cow seems to appreciate any attempt that is made to make her comfortable, and resents any treatment that tends to produce any excitement or disagreeable surroundings. A very noticeable effect occurred with our dairy cows immediately after the treatment of some pigs in the vicinity of the cow stalls, the squealing of these pigs affecting both the quality and quantity of the milk produced.

A WARM BARN. Dairy cows always appreciate a warm barn in winter. As they have a thin coat of hair and a thin hide, with a rather poor circulation of blood to the outside of the body, they are unable to stand the cold breezes that the beef steer can stand and thrive under. A barn need not be expensive, but it should be warm enough so that the animal heat will keep the manure from freezing.

FIGHTING FLIES. Flies are a torment to the dairy cow. Where possible, it is desirable to keep the cows during the day in a cool barn,

where the doors and windows are screened to keep out the flies, and allow the cows to run on pasture at night.

Where this arrangement is not possible, we have found by testing several fly mixtures, that it is possible to produce a mixture that will work reasonably well in keeping flies away, The best mixture that we have used, all things considered, seems to be that worked out by the Entomological Department of this Station, and is as follows: Resin, one and one-half pounds; laundry soap, two cakes; fish-oil, one-half pint; enough water to make three gallons. Dissolve the resin in a solution of soap and water by heating; add the fish-oil and the rest of the water. Apply with a brush. If to be used as a spray, add one-half pint of kerosene. The mixture will cost from seven to. eight cents per gallon, and may be used on either calves or cows. One-half pint of this mixture is considered enough for one application for a cow; a calf, of course, would require considerably less. It will be more economical to apply this only to parts not reached by the tail. At first it will perhaps be necessary to give two or three applications per week, until the outer ends of the hair become coated with resin. After that retouch those parts where the resin is rubbed off.

At the time of milking, we find that it materially adds to the comfort of the cow and the milker to have material like gunny-sacks that will reach the full length of the cow and come down low enough to hold her tail. This will keep the cow from switching her tail into the milk-pail and into the milker's face.

LICE. With the best of care, lice will sometimes appear on the cattle; they are readily gotten rid of by an application of kerosene emulsion or by using some of the dips that are extensively advertised and sold on the market.

IMPORTANCE OF A GOOD HERDSMAN.

The experience of the Kansas Experiment Station includes the man factor as well as the cow factor. In one instance we had a herdsman that was a good man to do what he was told and to draw his salary, but there his interest ended. When asked how the recent snow-storm or change of feed affected the yield of his cows he did not know, although he weighed and recorded each milking.

Following this man was a herdsman who was a graduate of the College, had taken special work along dairy lines, and was interested in every move that he made in caring for the dairy cows and calves. If a cow gave a few tenths of a pound more milk to-day than she did yesterday he was elated over the fact, and was always figuring how to account for it. On account of this interest he watched the feeding very closely, and was able to keep the cows in a rigorous condition,

and made some excellent records with those he was handling. In the case of calves, the former herdsman had made them gain 1.12 pounds per day, and the interested herdsman, with the same calves and the same feeds, made them gain at the rate of 1.8 pounds per day, an increase of sixty per cent. From experiences like this it will be seen that a poor herdsman is an expensive man, and that a good herdsman is an economical man, even though he be paid a good salary. As increased demands are made on our cows, there is the greater necessity for a herdsman to be both skilled and educated, and he must be able to direct his own movements as well as those of his helpers intelligently, and must produce an atmosphere that will cause every one assisting with the cows to be interested in the results that are being obtained.

VARIATIONS IN THE BUTTER-FAT TEST OF MILK, SKIM-MILK, AND CREAM.

Inquiries are frequently received at the Kansas Experiment Station in regard to the variation in the per cent. of butter-fat in milk and cream. The Station has been making tests of milk from the College herd for the last five and a half years, and the data in this bulletin have been gathered largely from this source.

As many of the inquiries about the test show a lack of knowledge about the principles involved in the Babcock test, a short statement in regard to some of the leading principles of the test are given before taking up the investigations relative to variations.

WHY IT IS NECESSARY TO TEST MILK. Any experienced dairyman or butter-maker knows that two cows standing side by side may vary greatly both in the quantity and quality of the milk produced, What is true of individual cows applies with equal force to different herds and to different breeds. Where butter is manufactured on the farm no injustice is experienced on account of the variation; but where the milk of two or more cows or herds belonging to different men is mixed in a receiving vat, and the butter manufactured from the cream obtained from this mixture, it is evidently unjust to pay the man who delivers 100 pounds of milk that makes only three or four pounds of butter the same as another man whose 100 pounds of milk make five, six or even seven pounds of butter. Again, if milk is paid for by the hundredweight, a man who is inclined to be dishonest will frequently water his milk.

METHODS THAT HAVE BEEN EMPLOYED. No one questions the accuracy of carefully conducted chemical analysis; it is the one method by which the accuracy of all other methods are compared. This process, however, requires delicate instruments, much time, and the service of a chemist, and consequently would be impracticable in

a large creamery. In the early days of the factory system cream gauges were used, but it was soon found that cream varied in composition even more than milk. Specific-gravity tests, test-churns, and oil-test churns, together with fifteen or twenty other tests, followed. These met with varying successes until 1890, when Dr. S. M. Babcock, of the University of Wisconsin, presented to the world a test which, on account of its cheapness, simplicity, and accuracy, has thus far practically supplanted all others.

THE BABCOCK TEST. When milk is allowed to stand, cream (milk containing a large number of fat globules) rises to the surface. With the Babcock test, sulphuric acid with a specific gravity of about 1.82 is added to the milk, to hasten and intensify this separation. The acid combines with all portions of the milk except the fat. If the test bottle be allowed to stand a few moments, the fat, being lighter than the rest of the mixture, forms a layer on the surface. If allowed to stand long enough, with a favorable temperature, nearly all the fat will rise to the surface. To hasten the separation of the fat, the test-bottle is placed in a centrifugal machine and revolved at the rate of 800 to 900 times per minute for a wheel twenty inches in diameter. See plates 40-43.

After separating the fat, hot water is used to raise it into the neck of the test-bottle, to be read. Although test-bottles can be made and graduated for any quantity of milk desired, they are usually made to test 17.6 cu. cm. (18 grams). Same bulk of acid is used as of milk.

In reading the column of butter-fat, it should be measured from the top to the bottom.

In measuring liquids in a glass tube, a true reading is obtained by measuring from the bottom of the column to the bottom of the meniscus at the top of the column. In testing milk and cream, however, it is found that a little butter-fat is lost in the process of testing, and chemical analysis shows that this loss is practically compensated for by reading from bottom to top.

The accuracy of the glassware used in the Babcock test is very important. Usually the dealers guarantee their glassware to be accurate, and there is at the present time little danger of error from this source. A good way for the average operator to test his test-bottle is to make a run of the same sample of milk in each of the bottles. If this is carefully done, the test ought to be the same in each of the bottles. If the entire outfit of bottles were inaccurate and this inaccuracy was uniform this method might not disclose the error.

If a pair of accurate druggist balances are available the test-bottles may be tested by filling them up to the zero mark with pure rain-water, preferably distilled water, then balance the bottle, and add

enough more water to fill the neck of the bottle to the last calibration. For every five per cent, marked on the bottle it should hold one gram (one cubic centimeter by volume) of water.

Another method of testing the accuracy of test-bottles is to thoroughly clean and dry them and weigh out 13.69grams of mercury for every five per cent. represented in the neck of the bottle and pour into the bottle. Take a piece of dry corn-stalk somewhat larger than the opening into the neck of the bottle, carefully peel off the outer hard coating, leaving the soft pith as round as possible. Press this pith sufficiently so it will fit snugly in the neck of the bottle, care being taken to have the end cut square across. Press this pith in until it reaches top graduation in neck of the bottle, tip the bottle upside down, and if the mercury completely fills the graduations in the neck of the bottle it is accurate. If it more than fills the graduations in the neck of the bottle, the latter will cause the milk or cream to test too high; if it does not fill the graduations in the neck of the bottle, it will cause the milk or cream to test too low.

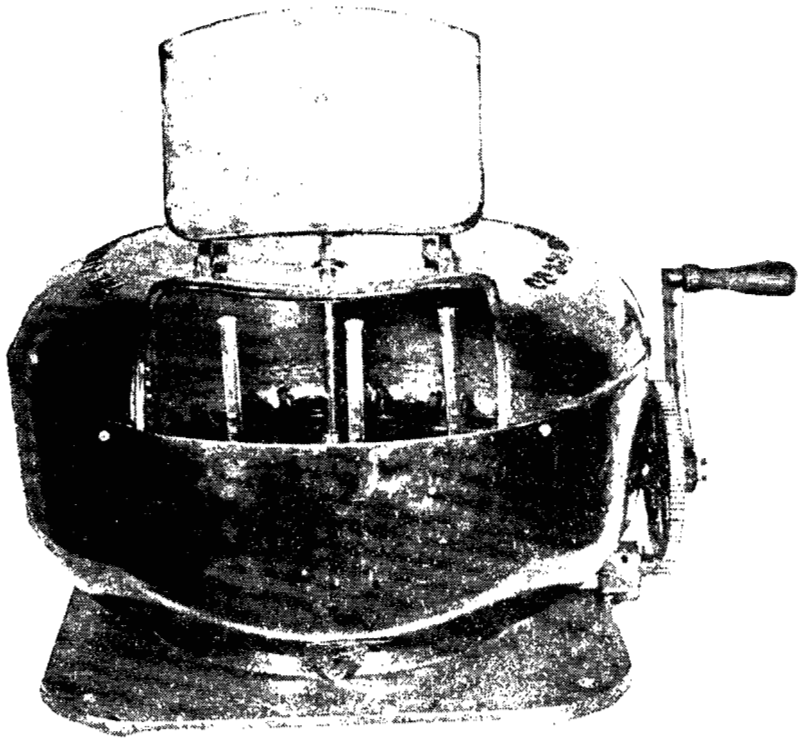

PLATE 40. The Jensen Improved Hand Tester. (Will handle long-necked cream bottles.)

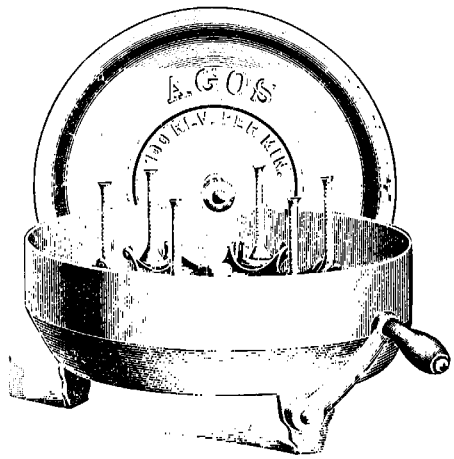

PLATE 41. Agos Hand Tester.

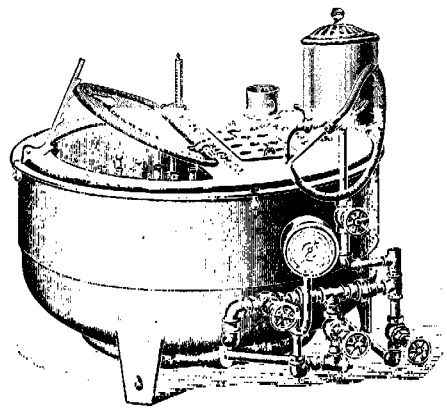

PLATE 42. Agos Steam Tester.

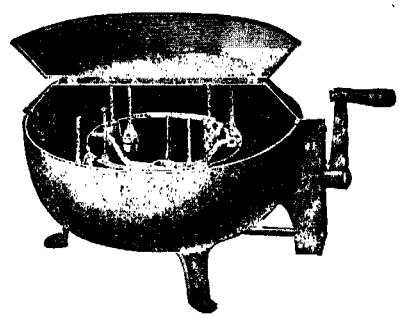

PLATE 43. Twentieth Century Noiseless Hand Tester.

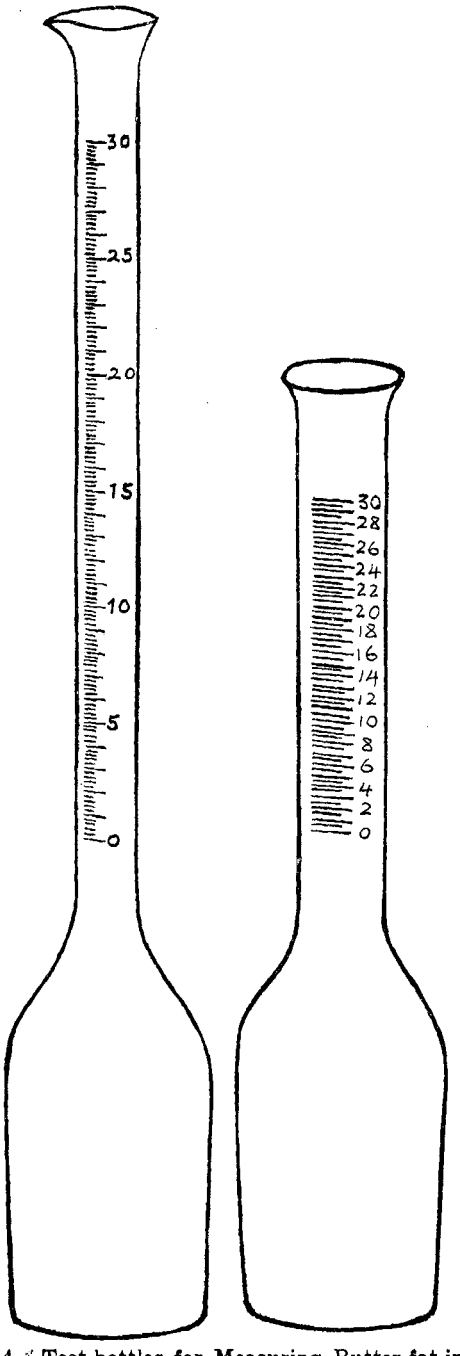

PLATE 44. Test-bottles for Measuring Butter-fat in cream.

Pipettes can be tested by a comparative test of the same sample of milk with a pipette and bottle of known accuracy. They can also be tested by weighing the amount of water they hold, allowing one gram for every five per cent. represented in the pipette. If an accurate burette, graduated in cubic centimeters, is available, the capacity of the pipette may be measured by emptying the pipette into the burette. The sulphuric acid (oil of vitriol) used in the Babcock test should have a specific gravity of 1.82 to 1.83. In handling the acid care should be taken not to expose it to the air, as it readily absorbs moisture, which will weaken it. If for any reason the acid being used is found to be too weak, larger quantities should be used.

The temperature of the milk influences the action of the acid. In a test made at this Station, it was found that with milk ranging from 55 to 60 deg. F. the butter-fat was nearly white, and the reading was from 0.1 to 0.2 lower than the same milk tested at a higher temperature. The acid and the milk should be thoroughly mixed together as soon as possible after the acid is added. In allowing it to stand without mixing, the acid in immediate contact with the milk is liable to char the fat and produce black spots, which make the reading difficult.

As butter-fat is found in milk in the form of drops (not solution, like sugar,) it is important that the milk should be thoroughly stirred before sampling. This is best done by pouring the milk from one vessel to another two or three times, and where the cream has risen for any length of time it may be necessary to increase the number of pourings.

IMPORTANCE OF KEEPING BOTTLES HOT IN HAND TESTERS. If the testing is done with a hand tester, it is very important that the bottles containing the mixture of acid and milk be kept hot; otherwise there will not be a complete separation of the fat. The following test (table XXX) of ten different samples of milk in a room where the temperature was between 64 and 70 deg. shows the possible variation, The water used in filling these bottles was 170 deg. F.:

TABLE XXX.—Testing milk in hand testers, with and without hot water.

SAMPLE.	Test without hot water.	Test with hot water.	Difference.
No. 1.....	3.5	3.6	0.10
No. 2.....	4.3	4.6	.30
No. 3.....	4.15	4.4	.25
No. 4.....	5.25	4.4	.15
No. 5.....	3 7	3.75	.05
No. 6.....	4.3	4.6	.30
No. 7.....	4.15	4.35	.20
No. 8.....	3.0	3.25	.25
No. 9.....	2.95	3.1	.15
No. 10.....	3.45	3.7	.25
Average.....	...		.20

Besides the average variation of 0.2 of 1 per cent., it was found that the tests made without hot water had considerable froth at the top of the fat column, which interfered greatly with correct reading. In steam-turbine testers the steam keeps the bottles sufficiently warm, and sometimes too warm, in which case the bottles should be allowed to cool to about 140 deg. F. before the reading is made.

IMPORTANCE OF HAVING MILK IN AN UNCHURNED CONDITION FOR TESTING.

In testing it is very desirable to have the milk or cream in an unchurned condition. Churned milk can be tested by the addition of ether or heating the sample, but both of these methods are cumbersome and unsatisfactory, and in the case of ether the results must be corrected according to the amount of ether used. When the samples have to be transported any distance, they should be placed in bottles small enough so that the sample will completely fill them. In sending a sample by mail, for instance, take a bottle with a wide cork and make a hole in the latter, thoroughly stir the sample of the milk to be tested and fill the bottle full; push in the cork, which will then cause a little of the milk to flow out of the opening. The cork can then be plugged up with a toothpick or match. The milk will then so completely fill the bottle that churning is impossible.

It should also be noted that when creamery patrons deliver churned milk to the creamery or skimming station the butter is usually caught by the strainer and the patron really gets a test that is lower in proportion to the amount of butter formed. It is a loss to both the patron and creamery, and is undoubtedly one of the causes of low tests.

Churned milk is apt to occur in summer, especially when the cans are not full. The need of keeping milk cool during the process of hauling is shown in the following summary of temperatures taken by the Kansas Experiment Station when the milk was delivered at the creamery by the patrons and haulers:

TABLE XXXI.—Summary of variation in temperature of milk delivered at Manhattan creamery July 29, 1898.

By whom delivered.	Number of patrons.	Average distance hauled, miles.	Temperature in deg. F.		
			High.	Low.	Average.
Patrons	9	2	90	77	81⅛
Hauler No. 1	5	3⅜	86	76	81
Hauler No. 2	7	4⅜	85	77	81⅛
Hauler No. 3	5	4	85	71	79½
Hauler No. 4	11	7 3/11	90	78	82 3/11
Hauler No. 5	7	7⅜	82	80	81⅛
Hauler No. 6	9	7⅞	88	76	83⅜
Hauler No. 7	10	7 1/10	97	80	85½

From this table it will be seen that the temperature varied from 71 degrees to 97 degrees, and many were so high that churning in a partially filled can would take place very readily.

TESTING SOUR MILK. Sour milk contains as much butter-fat as the same sample did while it was sweet, and, if tested before clabbering, will cause no difficulty in testing. After it has become clabbered, it is almost impossible to test sour milk, because of the difficulty of mixing the fat uniformly throughout the sample; furthermore, the clabbered milk is liable to clog up the pipette. Soda is sometimes added to break up the curd, but in tests made at the Kansas Experiment Station this method was found tedious as well as unsatisfactory in creamery practice.

TESTING FROZEN MILK. Frozen milk cannot be tested until all the frozen particles have been melted. The liquid portion of frozen milk contains a very large proportion of the milk solids, while the frozen-milk crystals are composed largely of water.

The effect of freezing milk was tested by two of our painstaking students in February, 1902. Duplicate tests of a fresh sample of milk showed 3.7 per cent. butter-fat. After this milk was frozen three days and four nights, it was thawed and tested again, with exactly the same result as before freezing. Another sample was tested in the same way with the same results.

COMPOSITE TESTING. Daily testing of individual cows, or even of a herd, involves much labor, but where it is desired to get only an average test, recourse is had to what is known as a composite test. This means that, each time a cow is milked during the test period, a small, uniform or proportionate amount is put into the sample jar in which is some preservative to keep it from souring — corrosive-sublimate tablets being commonly used for this purpose. The accuracy of the composite samples is shown in the following test made at this Station.

A composite sample of eight milkings just before the 1st and 15th of each month is made, which forms a part of the regular herd record. On May 10, 1899, a large herd of cows was put on green feed, and individual testing was done for seven days previous and for a number of days after the changing of the feed. This special test ran through the time of the regular test, and the comparison shown in the following table is between the average of the individual tests and the composite tests for the same milkings. The samples were taken by the milkers with no thought of the comparison being made. In taking the sample the milk was poured from the milking-pail into another pail, and a portion dipped out for the composite sample, using a dip.

per that held about two ounces. The milk was again poured back into the milk-pail, and again into the sample pail, and about a pint was poured out into a bottle for the individual tests. The results of the comparison are clearly shown in table XXXII.

TABLE XXXII.—Comparison of individual and composite sampling.

	1	3	4	5	6	7	8	9	10	11
Average of eight tests.	4.4	3.5	3.6	3.7	3.6	4.2	4.5	5.3	3.8	4.7
Composite test of same milkings.	4.4	3.6	3.7	3.7	3.5	4.2	4.5	5.4	3.8	4.6

	12	14	22	23	24	25	26	27	28	29	33
Average of eight tests.	5.1	4.5	4.1	4.2	3.3	4.1	4.3	4.0	4.7	4.7	3.9
Composite test of same milkings.	5.2	4.6	4.0	4.2	3.4	4.1	4.4	4.0	4.5	4.5	3.9

It will be noticed that 0.2 of one per cent. is the greatest variation that we had. For practical purposes, the composite sampling is not only accurate but saves a great deal of time.

VARIATIONS IN A SINGLE MILKING. A test was made at this Station with five cows that were giving a fair quantity of milk, their

TABLE XXXIII.—Variations in the test during a single milking.

No.	Test of cow.				
	No. 6.	No. 10.	No. 14.	No. 15.	No. 20.
1.	.6	.2	1.6	1.5	.8
2.	.7	1.0	2.3	1.8	1.1
3.	1.1	1.7	2.7	3.0	1.9
4.	1.5	2.1	2.8	3.6	2.6
5.	1.6	2.2	3.1	3.8	2.7
6.	1.8	2.4	3.1	4.0	3.0
7.	1.9	2.4	3.2	4.0	2.9
8.	2.0	2.7	3.0	4.1	3.0
9.	2.2	2.9	3.3	4.1	3.0
10.	2.4	2.9	3.1	4.2	2.9
11.	2.2	3.0	3.2	4 3	3.0
12.	2.2	3.1	3.3	4.3	3.2
13.	2.4	3.4	3.2	4.3	3.0
14.	2.0	3.3	3.3	4.4	3.1
15.	2.3	3.5	3.2	4.5	3 3
16.	2.4	3.6	3.2	4.7	3.2
17.	2.6	3.7	3.2	4.8	3.4
18.	2.9	4.0	3.4	5.0	3.5
19.	3.7	3.8	3.4	5.0	3.6
20.	5.6	4.2	3.5	5.3	4.0
21.	7.2	4.4	3.5	4.8	4.3
22.	.....	4.4	3.6	5.4	4.4
23.	.....	5.5	3.6	5.8	4.4
24.	.....	5.5	3 6	5.8	4.3
25.	.....	6.6	3.7	6.8	4.4
26.	.....	.....	3.9	.....	4.0
27.	.....	.....	3.9	.....	3.7
28.	.....	.....	3.9	.....	3.6
29.	.....	.....	4 0	.....	3.4
30.	.....	.....	4.0	.....	3.8
31.	.....	.....	4.2	.....	4.1
32.	.....	.....	4.2	.....	4.9
33.	.....	.....	4.3	.....	7.8
34.	.....	.....	4.6	.....	.....
35.	.....	.....	4.9	.....	.....
36.	.....	.....	5.8	.....	.....
Averages.	2.44	3.3	3.52	3.03	3.46

milk being collected into half-pint bottles, each teat contributing its share to every bottle. These different samples were tested for butter-fat, and the variation from the first to the last of the milking is shown in table XXXIII. It will be noticed in this table that the first milk drawn contains a very low per cent. of butter-fat — only 0.2 of one per cent. for cow No. 10 — and that there is a gradual, although not entirely uniform, increase from the first to the last of the milking. The last sample drawn is exceptionally rich in butter-fat, and stands in marked contrast to the first, or even the average, of the whole milking.

A summary of the averages, showing the per cent. of fat in the different portions of the milking, is given for each individual cow, as follows:

TABLE XXXIV. -Summary of butter-fat averages of single milkings.

Cow No. 6.

First half of milking, averaged 1.63% ; second half, 3.33%; increase, 104%.
First third of milking, averaged 1.31 ; last third, 3.81 ; increase, 190
First fifth of milking, averaged 0.97 ; last fifth, 4.85 ; increase, 400
First bottle of milking, averaged 0.60 ; last bottle, 7.20 ; increase, 1100

Cow No. 10.

First half of milking, averaged 2.30%; second half, 4.37% ; increase, 90%.
First third of milking, averaged 1.83 ; last third, 4.80 ; increase, 162
First fifth of milking, averaged 1.44 ; last fifth, 5.28 ; increase, 266
First bottle of milking, averaged 0.20 ; last bottle, 6.60 ; increase, 3200

Cow No. 14.

First half of milking, averaged 3.01% ; second half, 4.03% ; inorease, 33%.
First third of milking, averaged 2.89 ; last third, 4.28 ; increase, 48
First fifth of milking, averaged 2.68 ; last fifth, 4.57 ; increase, 70
First bottle of milking, averaged 1.60 ; last bottle, 5.80 ; increase, 262

Cow No. 15.

First half of milking, averaged 3.61% ; second half, 5.19% ; increase, 43%.
First third of milking, averaged 3.22 ; last third, 5.48 ; increase, 70
First fifth of miiking, averaged 2.74 ; last fifth, 5.72 ; increase, 108
First bottle of milking, averaged 1.50 ; last bottle, 6.80 ; increase, 353

Cow No. 20.

First half of milking, averaged 2.71%; second half, 4.26% ; increase, 57%.
First third of milking, averaged 2.44 ; last third, 4.40 ; increase, 80
First fifth of milking, averaged 2.14 ; last fifth, 4.47 ; increase, 108
First bottle of milking averaged 0.80 ; last bottle, 7.80 ; increase, 875

An average of the results indicates that the last quarter of a pint is worth from three-fourths to one and one-half pints of the milk first drawn from the udder. This test shows that when the calf gets the last of the milk it gets the richest portion. In the case of high-testing cow this would not only be a detriment to the calf (as too rich milk is liable to cause scours), but it also shows that the milker gets comparatively poor quality for his own use; furthermore, this test

shows that it pays to milk the cow clean; that when the cow is not milked clean the richest portion of the milk is left in the udder. This is not only a direct loss of fat but it also has a tendency to dry up the cow.

To further show the variation in the same milking, and to emphasize the importance of clean milking, a test with six cows, covering three days, was made by weighing and sampling the milk before the cow was milked entirely clean. The milker then finished stripping the cows, and a sample of the entire milking was taken. These samples were tested for butter-fat with the following results:

TABLE XXXV.—Effect of leaving the strippings.

Cow No.	June 25, P. M.				June 26, A. M.			
	Without strippings.		With strippings.		Without strippings.		With strippings.	
	Weight.	Test.	Weight.	Test.	Weight.	Test.	Weight.	Test.
14	4.0	4.4	5.5	3.8	7.5	4.6	10.5	5.0
72	3.5	3.0	5.6	4.8	4.5	2 6	9.2	4.8
128	10.2	2.8	10.7	5.4	12.7	2.5	14.1	3.1
130	13.0	3.55	14.3	4.2	15.7	3 6	17.6	4.2
131	11 0	2.2	15.5	3.8	13.5	2.4	15.5	3.3
168	7.9	3.3	9.4	3.6	10.0	3.3	10.9	3.4
	June 26, P. M.				June 27, A. M.			
14	4.9	3.8	6.0	3.9	7.0	2.9	9.2	3.5
72	5.9	3.5	6.6	4.6	7.2	4.0	8.8	5.0
128	9.2	2.75	9.9	2.9	11.1	2.7	11.6	2.9
130	12.2	3.6	13.8	4.2	13.8	2.9	17.3	3.5
131	13.6	3.6	15.4	4.2	14.7	3.1	16.2	3.4
168	7.8	3.3	9.0	4.3	8.7	3 4	9.9	3.6
	June 27, P. M.				June 28, A. M.			
14	8.0	4.95	8.2	5.5	6.5	3.4	9.3	3.7
72	5.0	4.2	6.9	5.1	7.2	3 6	8.2	4.1
128	10.3	2.8	10.8	2.9	11.5	2.7	11 6	2.9
130	11.9	3.3	14.7	3.8	15.4	3.1	17.3	3.6
131	16.2	5.0	17.1	5.2	15.0	3 0	16 1	3.5
168	8.5	3.3	9.8	3.6	9.7	3.35	10.6	3 5

DAILY VARIATIONS. Testing of individual cows shows that there is a variation from day to day. See table XXXVI.

TABLE XXXVI.—Daily variations of individual cows.

1898. Feb.	Time of milking.	Cow 1.	Cow 2.	Cow 3.	Cow 5.	Cow 6.
1.....	A. M	3.4%	3.6%	3.4%	2.8%	3.7%
	P. M	4.4	3.6	4.0	2.0	4.0
2.....	A. M	3.4	4.0	3.3	3.9	3.3
	P. M	4.2	3.8	4.2	5.2	4.2
3.....	A. M	3.2	3.1	3.4	2.4	3.4
	P. M	4.1	2.8	4.2	3.0	4 2
4.....	A. M	3.6	4.0	3.1	2.4	3.5
	P. M	4.0	2.7	3.6	4.2	3.4
5.....	A. M	3.1	3.9	3.4	3.7	3.3
	P. M	4.4	3.0	3.8	3.6	3.7
6.....	A. M	3.8	3.6	3.4	3.3	3 2
	P. M	3.6	3.4	3 6	1.5	3.6
7.....	A. M	3.4	3.4	3 3	2.8	3.7
	P. M	3.8	3.3	3.3	5.8	3.7

From the above table, it will be seen that it is not fair to take the test of a single milking, or even a single day, as representative of what a cow will test on an average.

VARIATIONS IN THE TEST OF HERDS. Variations also take place from day to day in the herd; usually, however, the herd variation is much less marked than that of the individual cows. The reason for this is that a variation upward in one cow is often offset by a variation in the opposite direction in another cow.

The test of the milk from the herd will also vary from month to month; this is also shown in table XXXVII.

TABLE XXXVII.—Monthly variation of herd.

MONTH.	1898.		1899.		1900.		1901.		1902.	
	No. of cows.	Test.	No. of cows.	Test.	No. of cows.	Test.	No. of cows.	Test.	No. of cows.	Test.
January	17	3.64	21	4.68	22	4.00	26	3.95	21	3.91
February	19	3.70	21	4.73	22	3.80	26	4.07	32	3.88
March	19	4.05	19	4.74	24	3.97	27	4.06	30	3.74
April	29	4.15	24	3.96	24	3.73	28	3.97	31	3.82
May	30	3.80	22	4.01	22	3.69	24	3.96	31	3.98
June	30	3.96	25	3.86	21	3.79	26	4.08	30	4.16
July	30	3.99	25	3.94	23	3.87	24	3.54	29	4.16
August	30	3.94	23	3.97	25	3.73	21	3.68	22	4.05
September	30	4.15	22	4.17	25	3.97	22	3.10	25	4.63
October	30	4.45	24	3.16	25	4.21	21	3.82	26	4.42
November	30	4.44	24	4.07	27	4.39	20	3.72	25	4.27
December	28	4.90	26	4 31	25	4.18	22	4.02	27	4.36

VARIATION UNDER REGULAR TREATMENT. A large number of the cows on the College farm have been tested for a number of consecutive milkings, and we invariably find more or less variations, not only in the test, but in the quantity of milk and butter-fat. Table XXXVIII, giving our experience with two of our cows, will suffice to show the extent of this variation.

TABLE XXXVIII.—Variations of cows under regular treatment.

FEBRUARY, 1898.

Cow No. 6.					Cow No. 18.				
Day.	Time.	Milk, lbs.	Test, per cent.	Butter-fat, lbs.	Day.	Time.	Milk, lbs.	Test, per cent.	Butter-fat, lbs.
2	A. M.	11.7	3.3	0.39	22	A. M.	9.1	3.6	0.33
	P. M.	10.1	4.2	.42		P. M.	7.0	3.5	.25
3	A. M.	11.85	3.4	.40	23	A. M.	9.8	3.4	.33
	P. M.	9.4	4.2	.39		P. M.	6.7	3.6	.24
4	A. M.	12 6	3.5	.44	24	A. M.	9.0	3.7	.33
	P. M.	10.0	3.4	.34		P. M.	6.9	3.8	.26
5	A. M.	12 8	3 3	.42	25	A. M.	9.0	3.4	.31
	P. M.	9.7	3.7	.36		P. M.	6.9	3.9	.27
6	A. M.	12.0	3.2	.38	26	A. M.	9.1	3.8	.35
	P M.	9.25	3 6	.33		P. M.	6.8	3.8	.26
7	A. M.	11.8	3.7	.44	27	A. M.	9.0	3.8	.34
	P. M.	9.45	3.7	.35		P. M.	6.9	3.6	.25
8	A. M.	12.3	3.4	.42	28	A. M.	9.4	3.4	.32
	P. M.	9 0	3.6	.32		P. M.	7.0	3 9	.27

VARIATIONS DURING LACTATION PERIOD. After the first few weeks there is a gradual increase in the per cent. of butter-fat as the lactation period advances. This is not always uniform, as will be seen from table XXXIX.

TABLE XXXIX.—Variations in test during lactation period.
Test for 1902 (expressed in per cents.)

Cow No.	Av. for year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
14.....	3.7	3.6	3.7	3.4	3.5	3.8	4.6	4.4	4.0	.....	.....	.....	4.0
20.....	4.1	4.2	4.2	4.4	4.2	4.7	6.4	7.6	....	.....	3.6	3.5	3.9
58.....	5.0	4.7	4.6	4.4	4.7	4.9	5.2	5.2	4.9	5.5	6.9	6.2	5.8
64.....	4.4	4.3	4.6	4.6	4.5	4.7	5.1	5.3	.....	.....	4.2	4.1	4.5
66.....	3.4	3.4	3.4	3.4	3.2	3.5	4.3	4.9	.....	4.1	3.2	3.5	3.6
70.....	3.6	3.8	3.9	4.0	3.8	3.6	4.0	4.0	.....	.....	3.5	3.1	3.5
128.....	3.1	3.0	2.8	2.8	2.9	2.9	3.2	3.3	3.7	4.9	3.6	.....	3.3
130.....	4.5	4.8	4.7	4.7	4.7	4.5	4.8	4.6	....	3.8	4.2	4.3	4.5
131.....	4.5	4.5	4.7	4.4	4.7	4.9	5.0	5.5	5.2	.....	4.2	4.3	4.6
166.....	3.4	.....	3.8	3.1	3.1	3.3	3.3	3.5	3.2	4.1	4.4	4.2	.....

VARIATIONS IN COLOSTRUM. The first milk drawn after the calf is born is called colostrum. It seems to be especiaily adapted to the young calf. It varies from the ordinary milk in that it contains less water and fat and a larger per cent. of albuminous matter, including broken-down cells and cell-walls of the udder. Very few tests have been made at this Station of colostrum milk, but the following example indicates the possible scope of the variation. The third-best cow in the herd calved in the afternoon, and that night her milk tested 4 per cent. butter-fat, and the next day 2.9 per cent. for each milking. On the evening of the third day the test had run up to 4.9 per cent., but decreased to 4.2 per cent. the next day. The fifth day it tested 4.7 per cent. in the morning and only 3 per cent. in the evening. On the sixth day the test took a sudden jump to 6.6 per cent. in the morning and 8.7 per cent. in the evening. On the morning of the seventh day it fell to 4.4 per cent., and in the evening to 2.2 per cent. It returned to and remained normal on and after the eighth day. In this case the highest test, 8.7 per cent., occurred on the thirteenth milking, and the lowest, 2.2 per cent. on the fifteenth milking. The greatest difference (4.3 per cent.) between two successive milkings occurred between the thirteenth and fourteenth milkings. Although there was this great fluctuation in fat the milk seemed to be perfectly wholesome, and was used after the ninth milking.

VARIATIONS DUE TO FEED. Much dispute has arisen in regard to the effect of feed upon the per cent. of butter-fat. On account of the fluctuations due to other causes, some of which have been mentioned above, it is very easy to attribute any variation that may happen to occur at the time of changing feed to the feed. The tables above

show that it is possible for a large variation to take place without any change of feed, Where accurate records have been kept, it has been found that there is very little if any change in the percent. of butter fat due to feed. A few recent experiments at other stations indicate that feed may influence in a small degree the per cent. of fat in the milk, but this influence is so small that it is hardly worth while for the average farmer or dairyman to pay any attention to it. The test of the richness of the milk seems to be the individual characteristic of the cow, that cannot be changed permanently by the will of man, and if we wish to increase the per cent. of fat in the milk, we must do it by breeding rather than by feeding. A change of feed may cause a temporary change in the per cent. of butter-fat; in fact, any change from the regular routine will cause the cow to fluctuate both in yield and the quality of her milk.

The question has been asked if a whole year of good feeding would in any way affect the cow, so that she would give richer milk the second year.

In January, 1898, the College purchased a herd of common cows from Lincoln county. These cows were in a rather poor, thin condition upon their arrival at the College. Of course, we had no record of their tests previous to their arrival, but we commenced testing them at once. A number of the cows in the herd, being rather poor individuals, were sold before their second year's record was completed; but there were ten of the number purchased from which we could draw a comparison. Table XL gives the results of these ten cows for the corresponding portion of the lactation period.

TABLE XL —Effect of a year of good feeding on the test.

Cow No.	Test in 1898.	Test in 1899.	Difference.
23	4.74%	4.82%	+0.08%
5	3.69	3.69	.00
11	5.04	4.60	— .43
33	3.60	3.58	— .02
9	4.03	4.11	+ .08
29	3.71	3.75	+ .04
7	4.12	4.00	— .12
24	3.23	3.27	+ .04
6	3.98	3.66	— .32
30	4.00	3.90	— .10
Average	.....	.....	—0.075

The above figures show that four cows gained in the per cent. of butter-fat, one cow remained exactly the same, and five lost in the per cent. of butter-fat. The average result shows a loss of 0.075 of one per cent. Of these ten cows, there were four that calved about the same month of each year; two of these gained in the percentage of butter-fat, the other two lost, the average showing neither loss nor

gain. Five of the cows began their lactation period from three to six months later in the second year than the first. Two of the five gained in the percentage of butter-fat and three lost.

While the average percentage of butter-fat for these ten cows decreased 0.075 of one per cent., our records show that the yield of butter-fat increased over thirty per cent. From this it will be seen that the year's feeding had very little to do in changing the percentage of butter-fat, but it did have a very marked influence on the yield of butter-fat. Experiments have been tried elsewhere to increase the amount of butter-fat in the milk by increasing the amount of fat in the feed, but all such efforts have resulted in failures.

The question is frequently asked if cows do not decrease in test when turned on pasture in the spring. On May 10, 1899, the College herd of common cows was divided into two lots, one half being put on pasture and the other half put on soiling crops. For one week (fourteen milkings) previous, and for one week after this date a butter-fat test was made of each milking of each cow. The following table gives a two weeks' sumrnary of the cows on pasture:

TABLE XLI.—Changes in test due to turning on pasture.

Cow No.	One week before pasturing.		One week after pasturing.		Difference.	
	Milk.	Test.	Milk.	Test.	Milk.	Test.
	lbs.	*per cent.*	*lbs.*	*per cent.*	*lbs.*	*per cent.*
5	174.1	3.94	160.0	3.65	—14.10	—0.29
9	56.5	5.13	66.7	5.06	+10.20	— .07
0	60.9	3.33	63.9	3.80	+ 3.00	+ .47
12	69.5	4.77	73.0	5.06	+ 3.50	+ .29
14	89.1	4.12	90.0	4.26	+ 1.10	+ .14
12	85.5	4.14	110.9	4.08	+25.40	— .06
23	160.2	3.99	159.2	4.25	— 1.00	+ .26
25	210.0	3.81	210.9	4.03	+ 0.90	+ .22
27	137.0	3.40	145.4	3.84	+ 8.40	+ .44
28	158.1	4.28	156.9	4.37	— 1.20	+ .09
23	227.8	3.46	226.4	3.82	— 1.40	+ .36
a						
Averages	.....	3.92	.....	4.10	— 3.16	+0.18

In all cases the test for the week is obtained by dividing the total yield of fat by the total weight of the milk. It will be noticed that seven cows gained in the yield of milk while four lost, the average being a weekly gain of 3.16 pounds per cow. Eight cows out of eleven gained in the per cent, of butter-fat, the average being a gain of 0.18 of 1 per cent. It is also interesting to note that one cow lost both in yield and test, while three others lost in yield but gained in test. In the latter case, the higher test caused each of the three cows to yield more butter-fat the second week than the first. Two cows gained in yield but lost in test, the increase in yield being suf-

ficient to cause an increase in the yield of butter-fat. There were five cows that gained both in yield and in test.

During the same period we carried on a similar experiment with the soiling cows, the results of which are shown in the following table:

TABLE XLII.—Changes in test due to changing from dry feed to soiling crops.

Cow No.	One week before soiling.		One week after soiling.		Difference.	
	Milk.	Test.	Milk.	Test.	Milk.	Test.
	lbs.	*per cent.*	*lbs.*	*per cent.*	*lbs.*	*per cent.*
1	111.4	4.51	115.3	4.47	+ 3.9	−0.04
3	185.9	3.38	178.4	3.45	− 7.5	+ .07
4	74.2	3.63	64.4	3.69	− 9.8	+ .06
6	192.5	3.47	187.4	3.42	− 5.1	− .05
7	225.7	3.97	208.1	4.22	−17.6	+ .25
8	50.4	4.43	47.3	4.55	− 3.1	+ .12
11	169.8	4.62	168.6	4.71	− 1.2	+ .09
24	233.6	2.97	238.7	3.09	+ 5.1	+ .12
26	154.9	4.12	147.2	4.19	− 7.7	+ .07
29	47.6	4.54	49.3	4.42	+ 1.7	− .12
Averages	.....	3.80	.....	3.89	− 4.2	+0.09

From this table it will be seen that the soiling cows did not yield as well as those on pasture. This is what might be expected in early spring, while the grass is green and succulent. Only three cows out of the ten gained in yield of milk, the average result being a weekly loss of 4.2 pounds per cow. Seven cows gained in the per cent. of butter-fat, the average result being a gain of 0.09) of 1 per cent. As in the pasture lot, one cow lost both in yield and test; six lost in yield and gained in test. Of the latter, two gained in the yield of butter-fat while four lost. Of the three that gained in yield, one gained in test while two lost, but all gained a little in butter-fat.

It should be noted that the cows in this experiment were all well fed during the winter, and the increase of yield from turning on pasture was very small, and in the case of soiling cows the yield was actually decreased. The results of the experiment indicate that, when cows are kept under good winter conditions, there is no increase in test due to pasture.

When cows come out of winter quarters in rather poor, thin condition, and their yield of milk has been decreased from lack of proper nourishment during the winter months, the fresh grass has a wonderful invigorating effect on their system and the yield of milk will undoubtedly be increased. But as the quantity of milk increases the test frequently decreases. This decrease of test can hardly be ascribed to the feed directly, although it does influence it indirectly by increasing the quantity of milk. The poor treatment that the cows received during the winter months resulted in partially drying them up, and

of course, as the cows dry up the test increases. The turning them on pasture would be partially restoring them to their normal condition.

EFFECTS OF CONDIMENTAL FEEDS ON THE TEST. Manufacturers of condimental stock foods sometimes claim that their foods will materially increaee the percentage of butter-fat. The Kansas Experiment Station tested two of these feeds for milch cows during the fall and winter of 1900–'01, Accurate account of the yield and teat of the milk was kept, and in no case were we able to find any material in. crease in the percentage of fat that could be attributed to the stock food.

VARIATIONS IN TEST DUE TO EXCITEMENT. In April, 1898, the Agricultural College bought twelve head of cows from Lincoln county. They were loaded on the cars in the afternoon and arrived at Manhattan, a distance of 100 miles, in the night, and were unloaded in the stock-yards. The next morning at four o'clock they were driven to the College and milked. An accurate record was kept of the weight and test of each cow for each milking for a period of about two weeks. The tests of five of these cows are presented in a table given below.

TABLE XLIII.—Variations in test due to excitement.

Cow No.	Time.	April 15.	April 16.	April 17.	April 18.	April 19.	Time required to return to the normal.
23	A. M.	3.0	3.6	2.9	3.1	3.1	Sixth milking.
	P. M.	7.2	2.8	3.4	3.4	3.4	
24	A. M.	1.0	1.2	4.9	2.7	2.9	Tenth milking.
	P. M.	0.9	4.5	4.2	3.2	3.0	
26	A. M.	1.5	2.4	7.2	5.4	3.9	Ninth milking.
	P. M.	2.0	3.7	11.1	4.8	4.2	
29	A. M.	1.1	3.4	4.1	3.3	4.1	Ninth milking.
	P. M.	1.2	10.6	6.1	.....	4.4	
32	A. M.	1.5	5.6	4.5	4.1	4.0	Seventh milking.
	P. M.	1.7	6.8	4.8	5.8	5.0	

Cow No. 23 showed a difference of 4.2 per cent. between milkings.

Cow No. 24 started out with a test of 1 per cent., decreased to 0.9 per cent. the second milking, raised to 1.2 for the third milking, and then jumped to 4.5 an increase of 3.3 per cent. from previous milking.

Cow No. 26 began with a test of 1.5 per cent., and gradually increased until the third day, when she suddenly jumped to 7.2, and then to 11.1 per cent., a remarkably high test. The greatest differ, ence between consecutive milkings is 5.7 per cent. She then gradually decreased, until the test became normal at her ninth milking.

No. 29 made a remarkably high test at her fourth milking, an increase of 7.2 per cent. over the previous milking, the greatest difference yet noted. She continued to fluctuate until her ninth milking.

No. 32 shows the greatest fluctuation between the second and third milkings, a difference of 3.9 per cent. While this cow reached her normal test at the seventh milking, she continued to fluctuate as much as 1 to 1.5 per cent. until April 24, the nineteenth milking.

During January, February, and March, 1902, the Agricultural College received nine cows from as many different dairymen in various portions of the state. As these cows came from various distances, and were on the road different lengths of time, the variation in their test is interesting. This variation is shown in the following table:

TABLE XLIV.—Variations in quantity and quality of milk found in shipping cows different distances.

TIME.	Cow Clover Leaf.			Cow Daisy Belle.			Cow Rose of Industry.		
	Milk yield.	Butter-fat test.	Solids not fat.	Milk yield.	Butter-fat test.	Solids not fat.	Milk yield.	Butter-fat test.	Solids not fat.
			pr. ct.			*pr. ct.*			*pr. ct.*
First day.. A. M.	.....	.....	.....	.....	.....	.....	.....	.....	.....
First day.. P. M.	8.1	4.2	8.08	11.2	5.4	6.67	13.9	4.7	8.91
Second day A. M.	13.2	6.0	8.05	1.4	13.21	10.21	9.4	8.2	8.64
Second day P. M.	11.6	3.6	8.62	3.1	7.4	8.55	11.3	5.2	8.41
Third day.. A. M.	14.9	3.1	8.52	6.4	5.1	7.94	12.8	6.6	8.57
Third day.. P. M.	12.3	2.8	8.56	6.5	4.6	7.59	12.2	5.7	8.51
Fourth day A. M.	15.3	3.5	8.95	6.4	4.8	8.33	12.8	4.7	9.06
Fourth day P. M.	10.6	3.6	8.47	6.4	4.4	8.73	12.2	5.5	7.51

From this table it will be seen that Clover Leaf started with a 4.2 per cent. test the first milking, raised to 6 per cent, the second, drop ping to 2.8 the fifth milking.

Daisy Belle started with a test of 5.4, which was raised to 13.2 the second milking, then gradually fell until she became normal, about 6.4 per cent. Here is a difference of 7.85 between two consecutive milkings. It is interesting to know also in this connection that the amount of milk varied from 11.2 pounds the first milking to 1.4 pounds the second milking.

Rose of Industry started with a test of 4.7, which was raised to 8.2 at the second milking, after which it fell, and finally became normal at about the eighth milking. This cow was shipped more than twice as far as any of the others, was on the road five times as long, and yet she did not vary as much as did Daisy Belle, who was on the road only twelve hours.

VARIATIONS FROM COWS BEING IN HEAT. Two cows from the College herd came into heat on the same day. Their yield and test of milk is as follows (pee table XLV):

TABLE XLV.—Variations in quantity and quality with cows in heat.

TIME.		Cow No. 62.		Cow No. 67.	
		Yield, lbs.	Test, per ct.	Yield, lbs.	Test, per ct.
First day..	A. M.	13.5	2.1	8.1	2 0
	P. M.	11.8	4.9	11.8	4.3
Second day	A. M.	13 4	3.2	8.3	5.0
	P. M.	12.2	3.6	7.8	4.4

During the first half of June, cow No. 62 gave nearly thirty pounds of milk per day, with an average test of 3.2 per cent, No. 67 gave twenty pounds of milk per day, with an average test of 4 per cent. Cow No. 67 shows a greater variation both in yield and test than cow No. 62. A peculiar variation is shown on the morning of the first day, in the very low yield and at the same time a very low test.

OTHER INFLUENCES THAT MAY AFFECT THE TEST. Any excitement or rough treatment, like the chasing by dogs, the squealing of pigs near the cows, driving cows long distances, flies, dehorning, or even a sudden change of feed or weather, a change of milkers, time of milking, length of intervals between milkings, rapidity of milking, a change in milking one teat at a time, the use of milking tubes, sickness or feverish condition of the system, or sympathetic feeling for other cows in distress, may cause temporary changes in both the quantity and quality of the milk.

Changes in the weather are liable to cause a change in the percentage of butter-fat. On Feburary 3, 1899, the Manhattan creamery received milk which according to usual calculations mould make 288 pounds of butter, but when the cream was separated it yielded only 227 pounds, or nearly twenty-one per cent. less than the usual run. The cause was ascribed to the cold weather and two days of snow.

These various experiences show that there are a variety of influences that may affect the test, and doubtless all the influences are not yet known. We find cows varying in test when there is no apparent reason, and the man who has not studied these problems will feel that there are reasons aside from the cow that caused a variation in this test.

VARIATIONS DUE TO SKIMMING CREAM. Not infrequently the breakfast table makes demands upon the cream which has risen to the top of the milk-can which has been set aside for the creamery or skimming station, and many think that a small quantity taken from these cans will make no difference in their test at the end of the month. A pint or even a quart from a can just once might not change the test very much, but when the practice is kept up each day the effect

is bound to be apparent. A careful test along this line was made by this Station. For five evenings the milk was taken; one-half pint, one pint and one quart was taken from as many forty-quart cans, by skimming with a quart cup. The cream was taken in the morning, after the milk had set in cold water all night, the test of the whole milk having been taken the evening before. Table XLVI gives the results obtained in this test.

TABLE XLVI.—Effect of removing small quantities of cream before sending milk to creamery.

Lbs. per can.	Test of whole milk.	Test after one-half pint cream was taken away.	Test after one pint cream was taken away.	Test after one quart cream was taken away.	Lost by taking away one pint.	Lost by taking away one quart.
87	4.0%	3.6%	3.4%	3.2%	1.53%	2.18%
87	4.1	4.0	3.7	3.5	1.07	1.95
57	4.1	4.0	3.7	3.1	1.13	2.70
57	4.1	3.9	3.3	3.0	2.09	2.93
51	4.0	3.9	3.7	2.9	0.93	3.04

The table shows that there is a considerable reduction in the average test of the milk by the taking of the cream. The taking of the cream from the top of the can means that we get the very richest portion, one-third of which is usually pure butter-fat.

PER CENT. OF BUTTER-BAT *vs.* PROFIT. Dairymen, and especially creamery patrons, are often carried away with the idea of a high test, and not infrequently they class the highest-testing cow as the best in the herd. It should be borne in mind that the test is only one factor in the element of profit. Frequently more depends upon the pounds of milk than upon the test. This is shown in tables XLVII–XLIX, which give the results of some of our low-, medium- and high-testing cows.

TABLE XLVII.—Low-testing cows *vs.* yield of butter-fat.

Cow No.	Milk for one year.	Average test.	Butter-fat for one year.
62	7,220.9 lbs.	3.36%	243.37 lbs.
128	7,967.5 "	3.03	242.13 "
166	8,517.0 "	3.31	282.75 "
61	6,152.7 "	3.68	226.93 "
33	7,524.8 "	3.67	276.49 "
Averages	7,476.5 lbs.	3.41%	254.33 lbs.

TABLE XLVIII.—Medium-testing cows *vs.* yield of butter-fat.

Cow No.	Milk for one year.	Average test.	Butter-fat for one year.
20	9,116.0 lbs.	4.21%	383.70 lbs.
72	7,782.3 "	4.26	331.76 "
130	7,577.4 "	4.43	336.00 "
134	7,598.8 "	4.35	330.53 "
241	6,790.0 "	4.12	280.32 "
Averages	7,772.9 lbs.	4.27%	332.46 lbs.

TABLE XLIX.— High-testing cows *vs.* yield of butter-fat.

Cow No.	Milk for one year.	Average test.	Butter-fat for one year.
246	4,558.0 lbs.	5.53%	251.9 lbs.
242	5,346.4 "	5.75	307.74 "
58	3,330.6 "	5.03	167.65 "
46	2,964.7 "	5.07	150.5 "
11	3,475.0 "	5.14	178.6 "
Averages	3,934.9 lbs.	5.36%	211.27 lbs.

It will be noticed that cow No. 20, with a test of 4.2, produced 383 pounds of butter-fat, and that cow No. 11, with a test of 5.1, produced only 178 pounds of butter-fat, a difference of 205 pounds in favor of the medium-testing cow. Figuring butter-fat at creamery prices, No. 20 brings an income of $40.37 over cost of feed, while No. 11 brings $7.60 over cost of feed. The experience of the Kansas Experiment Station, together with that of dairymen who have kept individual records, lead us to the conclusion that it is not always the highest- nor the lowest-testing cows that give the most profit. The medium-testing cow that gives a large flow of milk may be classed among the most profitable.

THE TEST OF WHOLE MILK DELIVERED TO VARIOUS CREAMERY SYSTEMS OF THE STATE. While experimenting with dairy cows and studying some of the causes of variation in the quality of milk, the Station has also been collecting data as to the tests of milk delivered to creameries in various parts of the state. These data, submitted in tables L-LIV, are both interesting and instructive in showing the variations that take place in the different months of the year and in different sections of the state.

TABLE L.—Average test of whole milk delivered by patrons of the Continental Creamery Company, Topeka, for one year.

NAME OF SYSTEM.	No. of skimming stations in system.	1902.							1903.				
		June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.
Abilene	26	3.76	3.65	3.68	3.96	4.10	4.02	4.05	3.86	3.76	3.66	3.57	3.59
Wichita	41	3.84	3.88	3.93	4.23	4.35	4.17	4.18	4.08	4.04	3.89	3.77	3.73
Topeka	37	3.62	3.67	3.59	3.83	4.04	4.09	4.14	3.95	3.72	3.66	3.60	3.61
Salina	46	3.67	3.67	3.72	4.02	4.19	4.14	4.46	4.52	3.89	3.83	3.63	3.71
Great Bend	33	3.55	3.66	3.69	3.99	4.25	4.18	4.22	4.37	4.19	3.70	3.72	3.71
McPherson	26	3.65	3.64	3.64	3.84	4.01	3.85	3.93	3.78	3.61	3.56	3.46	3.52
Belleville	58	3.72	3.74	3.87	4.16	4.34	4.33	4.34	4.12	3.93	3.93	3.74	3.83
Beloit	28	3.66	3.66	3.68	4.20	4.18	4.11	4.12	3.80	3.89	3.75	3.52	3.53
Council Grove	17	3.82	3.82	3.86	4.18	4.46	4.20	4.24	4.19	4.00	3.95	3.72	3.83

The territory covered by the different systems is as follows:

ABILENE SYSTEM.—Skimming stations in Dickinson, Clay and Cloud counties.

WICHITA SYSTEM.—Skimming stations in Cowley, Butler, Sedgwick, Sumner, Kingman and Harper counties.

TOPEKA SYSTEM.—Skimming stations in Jefferson, Shawnee, Osage, Riley and Wabaunsee counties.

SALINA SYSTEM.—Skimming stations on main line of Union Pacific and Lincoln branch of Union Pacific, west of Salina, all in Kansas.

GREAT BEND SYSTEM.—Skimming stations on Denver line Missouri Pacific west of Hoisington, in Kansas, and main line of Santa Fe west of Great Bend, in Kansas.

MCPHERSON SYSTEM.—Skimming stations in Marion, Dickinson, Morris, McPherson, Rice and Reno counties.

BELLEVILLE SYSTEM.—Skimming stations on Rock Island west of Belleville, in Kansas.

BELOIT SYSTEM.—Skimming stations on Central Branch of Missouri Pacific from Greenleaf west.

COUNCIL GROVE SYSTEM.—Skimming stations in Morris, Lyon, Greenwood and Chase counties.

TABLE LI.—Number of patrons and average test of whole milk delivered to the Clyde creamery, Clyde, for five years.

MONTHS.	1902.		1901.		1900.		1899.		1898.	
	No. of patrons.	Average test.	No. of patrons.	Average test.	No. of patrons.	Average test.	No. of patrons.	Average test.	No. of patrons.	Average test.
January.....	272	4.09	304	4 13	220	4.03	255	4.01	245	4.00
February.....	224	4.06	305	4.09	230	3 96	280	4.03	262	3.91
March.....	245	3.80	3 5	3 89	299	3.79	325	3.91	290	3.83
April.....	261	3.65	3 9	3.83	339	3.65	325	3.71	308	3.77
May.....	405	3.62	427	3.64	400	3.59	453	3.71	422	3.70
June.....	489	3.74	508	3.79	430	3.62	604	3.73	440	3.71
July.....	488	3.80	451	3.65	386	3.54	511	3.71	428	3.74
August.....	475	3.76	4 9	3.80	387	3 61	433	3.72	362	3 78
September.....	428	4 09	351	4.09	316	4.01	360	4.02	288	3.97
October.....	331	4.27	304	4.26	295	4.17	268	4 31	216	4 23
November.....	289	4.27	289	4 24	267	4.27	234	4.21	212	4.27
December.....	256	4.41	274	4.29	271	4.23	219	4.15	206	4.01
Averages.. ..	345	3.89	355	3.85	323	3.80	356	3.85	307	3.86

TABLE LII.—Average test of whole milk delivered to five stations of the Forest Park Creamery Company, Ottawa, for four years.

MONTHS.	1902. Average test.	1901. Average test.	1900. Average test.	1899. Average test.
January.....	4 58	4.11	4.21	4.21
February.....	4.11	4.14	4.23	4.13
March.....	3.94	4 00	4.20	4.07
April.....	3.95	4 25	4.13	3.89
May.....	3.73	3.91	38.5	3.83
June.....	3.69	3 78	3 68	3.83
July.....	3.73	3.79	3.83	3.91
August..	3.72	4.02	3.78	3.88
September.....	3 99	4.03	4.16	4 06
October.....	4.13	4 24	4.41	4.12
November.....	4.10	4.41	4.55	4.36
December.....	4 36	4 54	4 39	4.38

The number of patrons varied from 200 in the winter months to 500 during the summer months.

TABLE LIII.—Average test of whole milk delivered to the Hesston creamery, Newton, for five years.

MONTHS.	1902. Average test.	1901. Average test.	1900. Average test.	1899. Average test.	1898. Average test.
January.....	3 93	3.92	4.04	4.03	3.85
February.....	4.14	4.03	4.12	4.05	3.73
March.....	3.76	3.76	3.88	3.84	3.64
April.....	3.81	3.73	3.75	3.71	3.62
May.....	3.65	3.66	3.79	3.65	3 71
June.....	3.84	3 74	3.75	3.75	3.71
July.....	3 76	3.89	3.70	3.69	3 71
August.....	3.79	3.79	3.79	3.89	3.80
September.....	4.27	4 13	3.99	3.95	3 99
October.....	4.37	4.34	4.26	4.13	4.14
November.....	4.25	4.04	4.11	4.13	4.13
December.....		4.15	3.99	4.12	4.21

Number of patrons varied from 650 to 1250.

TABLE LIV.—Average test of whole milk delivered to the Hillsboro creamery, Hillsboro, for five years.

MONTHS.	1902. Average test.	1901. Average test.	1900. Average test.	1899. Average test.	1898. Average test.
January	3.76	3.71	4.00	4.11	3.90
February	3.80	3.73	3.97	3.91	3.67
March	3.58	3.60	3.93	3.61	3.61
April	3.38	3.45	3.65	3.52	3.60
May	3.47	3.36	3.69	3.72	3.60
June	3.59	3.41	3.75	3.77	3.65
July	3.50	3.36	3.69	3.65	3.74
August	3.50	3.06	3.69	3.60	3.71
September	3.90	3.89	4.00	3.90	4.00
October	3.93	4.01	4.25	3.90	4.15
November	3.77	3.66	4.00	4.00	4.18
December	3.77	3.80	3.88	4.00	4.25

Number of patrons varied from 130 to 150.

CREAM TESTING.

With the rapid increase of hand separators the subject of accurately testing cream becomes a very important one. It is impossible to test cream correctly in the same way you test milk. The reason of this is, that the cream may vary in its content of butter-fat from twelve or fifteen per cent. to as high as fifty or sixty per cent. On account of this variation, the weight of a given volume varies considerably. As the Babcock test is based on weight rather than volume, it stands to reason that this variation would produce inaccuracy in results where cream is measured. With milk the per cent. of fat is much more uniform, and samples can be measured that will weigh so closely to the amount required that it answers all practical purposes. Furthermore, in handling cream a large number of air bubbles are liable to be incorporated in it; this will also give us considerable variation in a given volume. In measuring the column of butter-fat in cream, special attention must be paid to the temperature; for best results this should be 140 deg. F. If it varies much above or below this there will be considerable contraction or expansion of the fat, which will produce inaccurate results.

VARIATIONS IN THE TESTS OF CREAM. At first thought one might expect that, with the same separator, the same speed, and no change in the cream screw, the test of cream would be uniform. Experience shows that this is not the case. The amount of water used in flushing the bowl will vary enough to give a variation to the cream. The speed of the machine may not always be the same, even with the same man running it. The faster the machine is turned the thicker the cream. The rate of feed will cause variation; if the milk is fed slower the cream will be thicker. The temperature of the milk may not always be the same, the warm milk usually producing richer cream. Where the milk is from the same cows and the conditions as to sepa-

ration are practically uniform, there ought to he, and doubtless will be, much more uniformity in the richness of the cream, especially if the proportion of the milk and cream remain uniform.

During the past winter the dairy department made a test of the different hand separators, and although in this test every effort was made to have the conditions just as uniform as possible, it was still noted that the variation of the per cent. of cream was considerable in all the machines that were tested.

Results with two of these machines have been taken, from figures furnished by one of our senior students, Mr. E. W. McCrone, who did considerable work along these lines for his graduating thesis. The results obtained with all the machines show practically the same variations as the illustrations given in table LV.

TABLE LV.—Variations in per cent. of butter-fat in cream separators under normal and practically uniform conditions.

Separator No. 1.				Separator No. 2.			
No. of trial.	Temperature of milk.	Babcock test.		No. of trial.	Temperature of milk.	Babcock test.	
		Milk.	Cream.			Milk.	Cream.
1.....	89	4.0	38.4	1.....	90	4.2	44.3
2.....	90	4.1	38.8	2.....	93	4.1	34.4
3.....	90	4.2	33.8	3.....	90	3.6	30.9
4.....	90	3.2	39.2	4.....	93	4.2	35.0
5.....	90	4.1	32.8	5.....	90	4.0	38.1

It will be noticed that in trials 2 and 3 under hand separator No. 1 the temperature of the milk was not exactly the same; the per cent, of butter-fat was only 0.1 per cent. different, while the per cent of cream varied 5 per cent. In trials 4 and 6 it will be seen that the temperature was exactly the same, but the test varied from 3.2 to 4.1; when it came to cream, the low-testing milk produced the highest-testing cream.

With hand separator No. 2 the temperatures varied somewhat, but where the test is the same the high-temperature milk does not seem to produce as rich cream as the low-testing milk. However, the difference in temperature of three degrees would make comparatively little difference. In trials 1 and 2, it will be seen that there is a variation of 10 per cent. in the richness of the cream.

These great variations in the per cent. of cream with milk at the same temperature, with practically the same per cent. of butter-fat, hardly seems creditable, and yet this is true with every machine we have tested. Just why there should be this great variation we are unable to explain.

VARIATIONS IN TEST OF SKIM-MILK. As cream and skim-milk are so intimately associated, and as we do not have one without the other, it is interesting to note the variations that take place in the skim-milk. In the following table we have arranged the different hand separators according to numbers, rather than by names, for the reason that if we give the names one might draw comparisons between the different machines that would be unfair, for the reason that there are other considerations to be taken into account.

TABLE LVI.—Variations in the test of skim-milk with different hand separators.

Separator No.	Range of variation.	Average. test.
1.....	0.03 to 0.06	0.04
2.....	.03 to .05	.04
3.....	.03 to .05	.03
4.....	.03 to .08	.05
5.....	.03 to .08	.05
6.....	.01 to .04	.03

The tests of this skim-milk were taken at the same time as the tests of cream mentioned above. It will be seen that, although there is a great variation in the per cent. of cream, practically none of this variation is due to an increase of butter-fat in the skim-milk.

EFFECT OF LOW SPEED UPON THE TEST OF SKIM-MILK. With two of the machines a test was made of running the milk through the machine at about three-fourths of the listed speed. The results are shown, as follows:

TABLE LVII.—Test of skim-milk with hand separators run at three-fourths listed speed.

SEPARATOR.	Run.	Test.
1.....	1	.16
1.....	2	.19
2.....	1	.25
2.....	2	.15

In this test it will be seen that the amount of butter-fat in the skim-milk is materially increased by lowering the speed.

EFFECT OF COLD MILK ON THE TEST OF SKIM-MILK. A temperature of 90 deg. F. is usually regarded as the most favorable for separating milk. To ascertain the effect of separating milk at a lower temperature, four machines were used in separating milk at a tem., perature of about 75 deg. F. The results are shown as follows:

TABLE LVIII.—Test of skim-milk when whole milk was separated at 75 deg. F.

SEPARATOR.	Run.	Test.
1.....	1	.075
1.....	2	.055
2.....	1	.085
2.....	2	.04
3.....	1	.175
3.....	2	.075
4.....	1	.10
4.....	2	.15

It will be noticed that the cold milk did not have as much effect on the test of the skim-milk as the slow speed; nevertheless, there is considerably more loss than where the separators are run at their listed speed.

TEST OF SKIM-MILK FROM AQUATIC, HYDRAULIC OR DILUTION SEPARATORS. During the last few years a large number of so-called separators that have passed under the names of "Aquatic," "Hydraulic," "Dilution," etc., have been extensively advertised and sold at from eight to fifteen dollars apiece, the agents claiming that they would do the work of a high-priced separator. Prof. Ed. H. Webster, formerly dairyman at this Station, made a thorough test of one of these machines. Out of 184 pounds of whole milk testing 3.2 per cent. butter-fat put into this machine, he drew off 168 pounds of skim-milk and 16 pounds of cream, The cream tested 11.1 per cent. and the skim-milk 1 per cent., or a loss of 1.68 pounds of butter-fat in 168 pounds of skim-milk.

Another example that came under our observation was that of a man that lived at Kinsley, Kan. His so-called separator held ten gallons of milk, which at the time of the test contained four per cent. of butter-fat. After standing for five hours only three gallons of the thinnest skim-milk was drawn from the bottom and found to contain 1.2 per cent. fat. If all the skim-milk had been drawn it would have undoubtedly tested higher. In both of the above tests no water was added to the milk.

In Bulletin 151 of Cornell University, two tests are given where as much water as milk was added to the milk. In each test six trials were made. In the first one the skim-milk tested 0.76 per cent. to 1.2 per cent., with an average of 0.94 butter-fat. In the second the skim-milk tested from 0.66 to 1.4, with an average of 1.01 per cent. butter-fat. A test of the skim-milk from a Cooley creamer, made at the same time, varied from 0.9 to 1.2, with an average of 1 per cent. butter-fat.

These tests indicate very plainly that a large amount of butter-fat is left in the skim-milk of these so-called separators, and, as far as

the test of skim-milk is concerned, they are about as efficient as any ordinary tin can of the same size.

TEST OF SKIM-MILK UNDER THE GRAVITY SYSTEM. Milk that has had the cream removed by hand, in the old basin, pan or crock system, contains much more butter-fat than separator milk. An illustration of this is furnished in a sample tested by an advanced student in the dairy course, where he found that the whole milk tested 4.4 per cent, butter-fat, and the skim-milk left by hand skimming 1.7 per cent. With a cow that produces 6000 pounds of milk per annum, this would mean a loss of 102 pounds of butter-fat during the year, The loss of fat by hand-skimming will vary a great deal by the way the milk is handled.

SUMMARY. In the portion of this bulletin devoted to testing the aim has been to show some of the causes of the variations in the tests of milk, cream, and skim-milk, and also to show the range of variations that may take place under varying conditions. The reader will observe that there is a large number of variations for which we are unable to give any adequate reason, but they nevertheless do occur, and we should know the fact, and later may be able to discover the cause. On account of these variations more or less friction is liable to occur between the creamery man and the patron. Neither party can afford to have any friction of this kind, because each is dependent upon the other for business success, and both should know that variations do take place, and both should also be willing to investigate, and, if possible, find out where the variation comes in, and not feel that the other is trying to cheat him. The more we know about tests the less positive we are that we can tell just what will take place, and the more we know about it the more lenient we ought to become.

Successful dairying involves considerable testing, both of individual cows and of milk and cream sent to the creamery or skimming station. No dairyman can afford to continue to milk cows unless he knows what they are doing, and he is unable to know this without weighing the milk and testing it from time to time for its butter-fat content. For this reason it behooves every dairyman to have a hand tester, at least; it will soon pay for itself from a monetary standpoint, besides adding much interest and satisfaction to the owner who is milking the cows. It will enable him to know which cows are his money-makers and what cows are his debt-contractors,

The feeding and handling of cows and cow products is a business proposition, the same as handling dry-goods or groceries, and should be done on business principles. The Babcock tester and the milk-scales will show where the leaks come in and in which direction the efforts should be directed to remedy the trouble.

Plate 1. Cow No. 5. Record, 3583 pounds of milk; 135.7 pounds of butter-fat in twelve months.

Plate 2. Cow No. 5—rear view.

Plate 3. Cow No. 7. Record, 6966.4 pounds of milk; 334.55 pounds of butter-fat in tmelve months.

Plate 4. Cow No. 20. On arrival at Kansas Experiment Station.

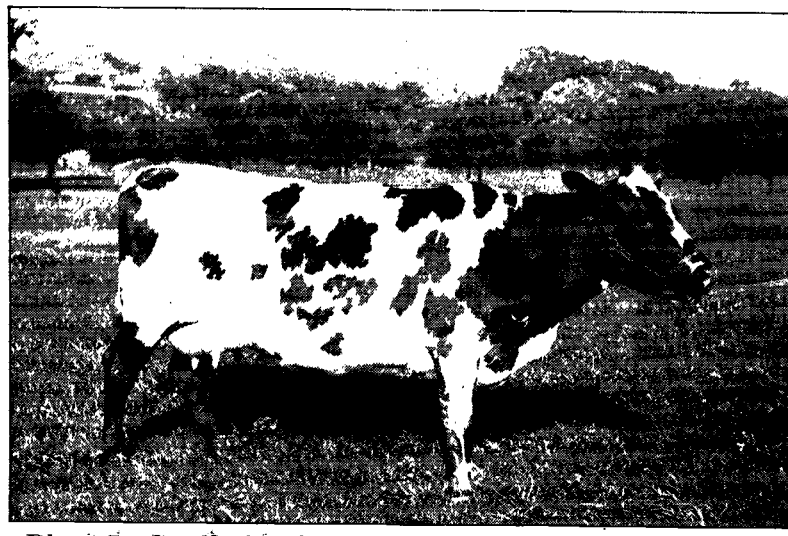

Plate 5. Cow No. 20. One year later. Record, 9116.5 pounds of milk; 383.7 pounds of butter-fat in twelve months.

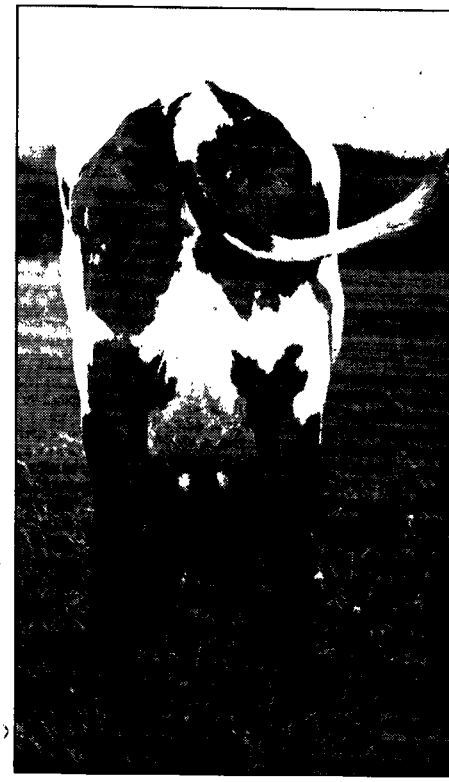

Plate 6. Cow No. 20—rear view.

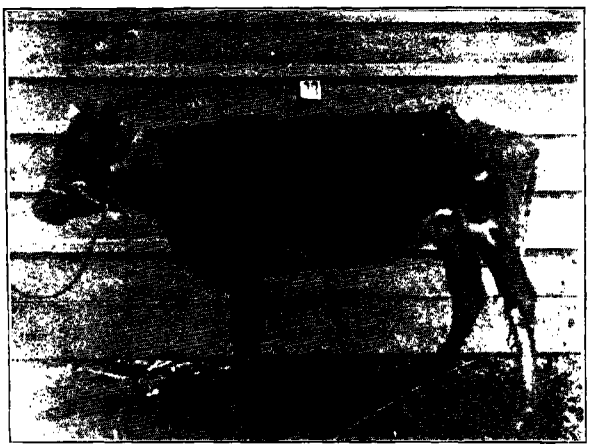

Plate 7. Cow No. 23. On arrival at Kansas Experiment Station.

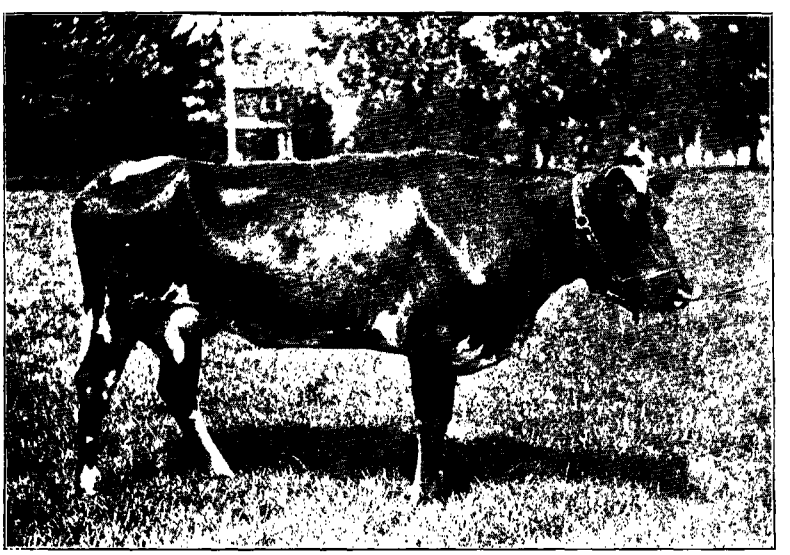

Plate 8. Cow No. 23. One year later. Record, 7838.9 pounds of milk; 290.62 pounds of butter-fat in twelve months.

Plate 9. Cow No. 23—rear view.

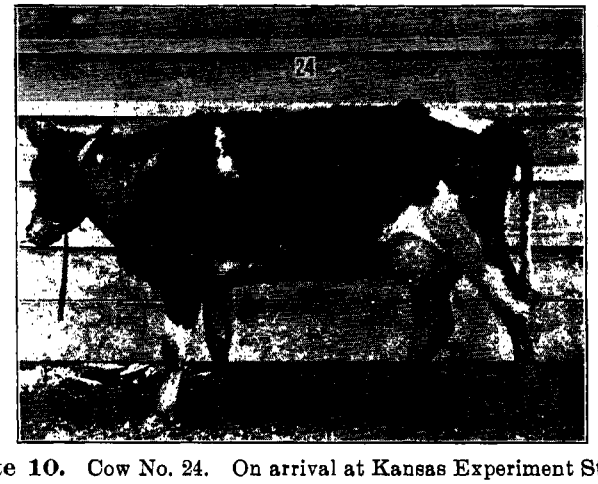

Plate 10. Cow No. 24. On arrival at Kansas Experiment Station.

Plate 11. Cow No. 24. One year later. Record, 8077.6 pounds of milk; 278.31 pounds of butter-fat in twelve months.

Plate 12. Cow No. 24—rear view.

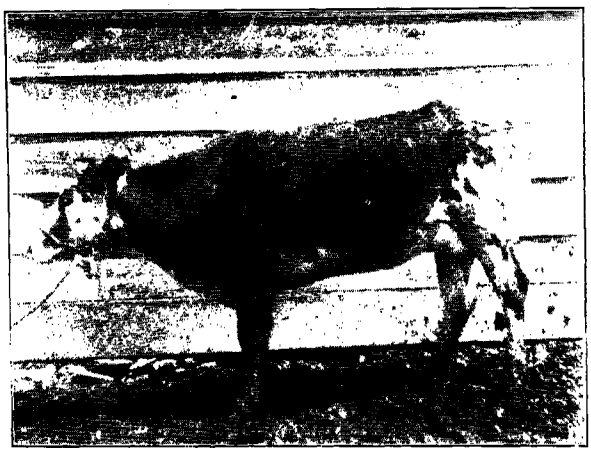

Plate 13. Cow No. 25. On arrival at Kansas Experiment Station.

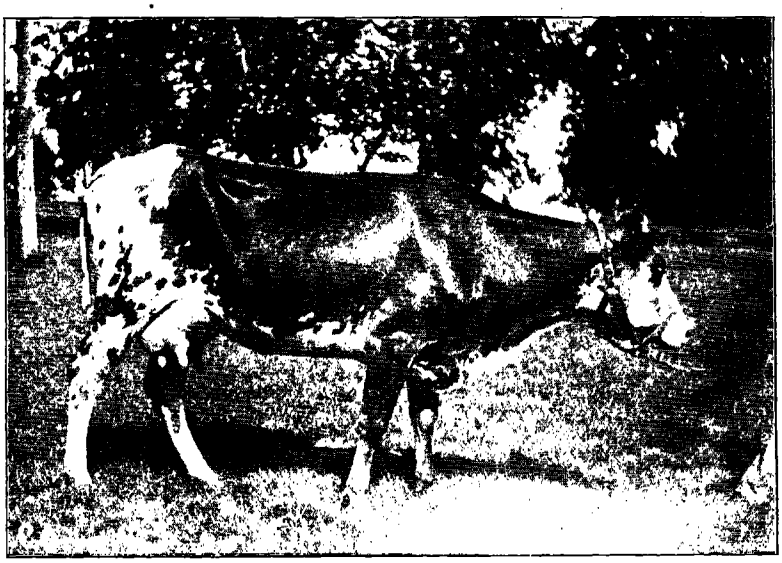

Plate 14. Cow No. 25. One year later. Dam of No. 47. Record, 5952 pounds of milk; 251.5 pounds of butter-fat in twelve months.

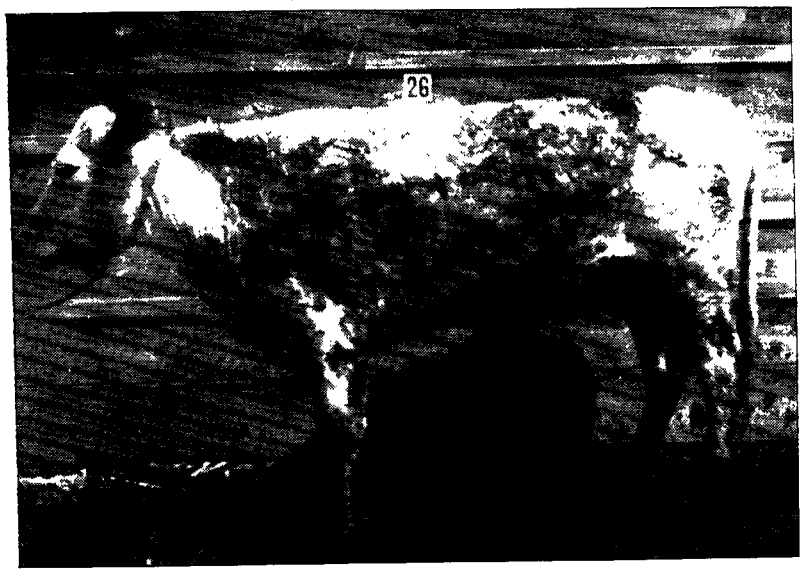

Plate 15. Cow No. 26. On arrival at Kansas Experiment Station.

Plate 16. Cow No. 26. One year later. Record, 5795 pounds of milk; 251 pounds of butter-fat in twelve months.

Plate 17. Cow No. 26. Rear view.

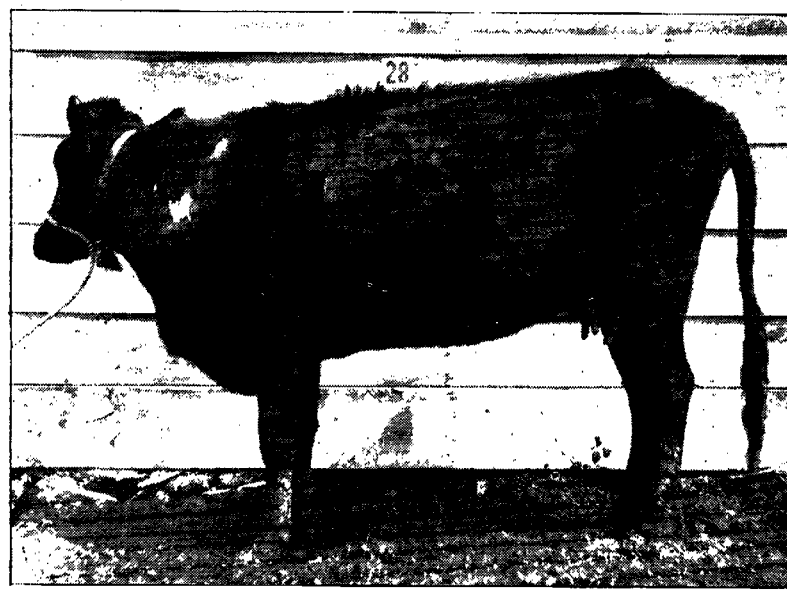

Plate 18. Cow No. 28. On arrival at Kansas Experiment Station.

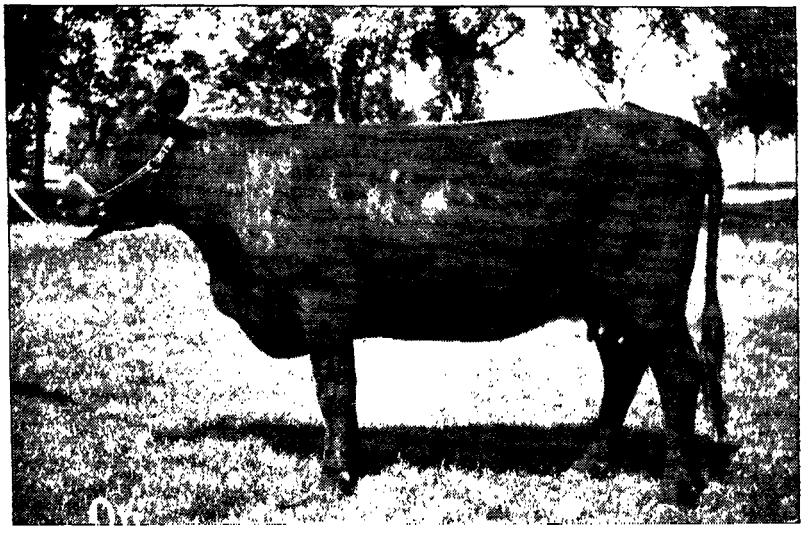

Plate 19. Cow No. 28. One year later. Record, 2141 pounds of milk; 101.5 pounds of butter-fat in twelve months.

Plate 20. Cow No. 28—rear view.

Plate 21. Cow No. 29. A poor cow. Record, 3730 pounds of milk; 157.8 pounds of butter-fat in twelve months.

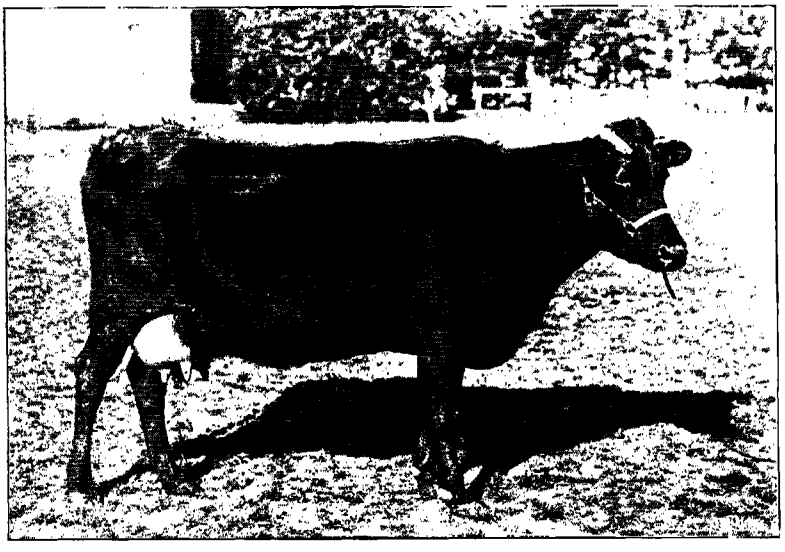

Plate 22. Cowslip. Selected by J. W. Bigger, North Topeka, Kan. Record, 6285.5 pounds of milk and 314.35 pounds of butter-fat in twelve months.

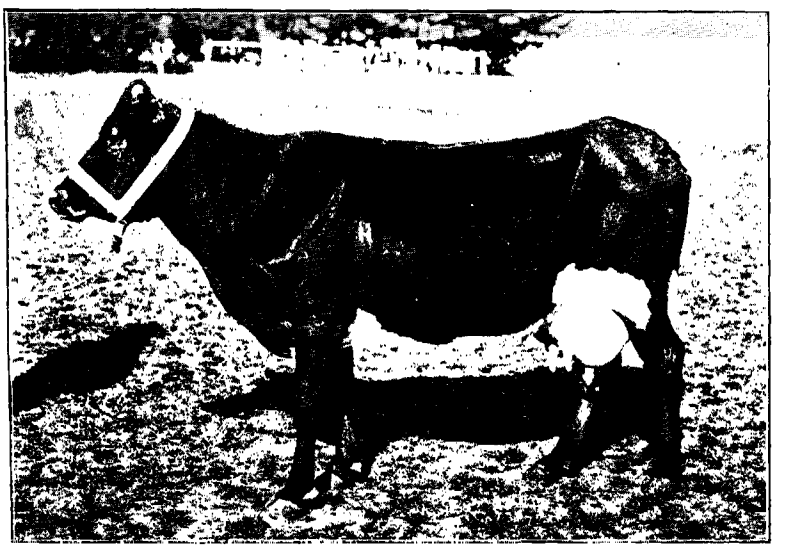

Plate 23. Haster. Selected by E. C. Cowles, Sibley, Kan. Record, 5663.5 pounds of milk and 274.89 pounds of butter-fat in twelve months.

Plate 24. Rose of Cunningham. Selected by J. W. Cunningham, Meriden, Kan. Record, 8107 pounds of milk and 324.18 pounds of butter-fat in twelve months.

Plate 25. Clover Leaf. Selected by M. L. Dickson, Edgerton, Kan. Record, 5530.9 pounds of milk and 200.28 pounds of butter-fat in twelve months.

Plate 26. Molly. Selected by A. H. Diehl, Chapman, Kan. Record, 5096.9 pounds of milk and 222.3 pounds of butter-fat in twelve months.

Plate 27. Rose of Industry. Selected by C. Elsaaser, Industry, Kan. Record, 5972.9 pounds of milk and 273.17 pounds of butter-fat in twelve months.

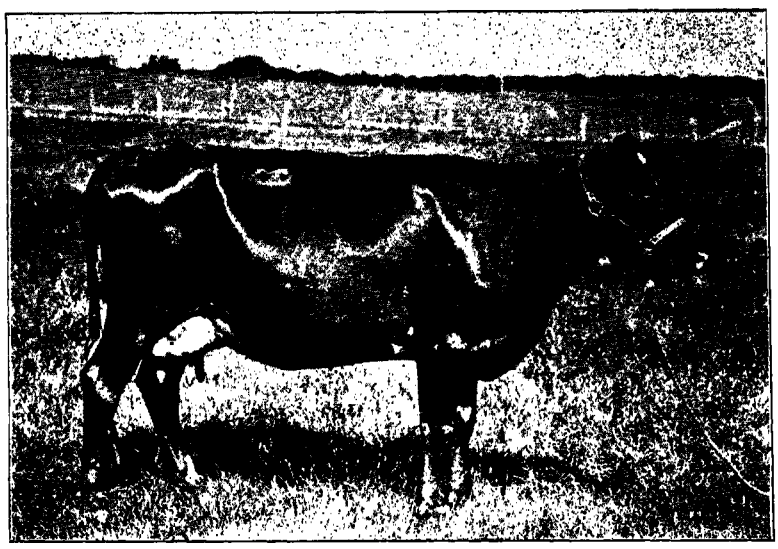

Plate 28. Daisy Belle. Selected by S. A. Johnson, Kingman Kan. Record, 6329.7 pounds of milk and 273.24 pounds of butter-fat in twelve months.

Plate 29. Floss. Selected by C. C. Lewis, Baldwin, Kan. Record, 4230 pounds of milk and 251.9 pounds of butter-fat in twelve months.

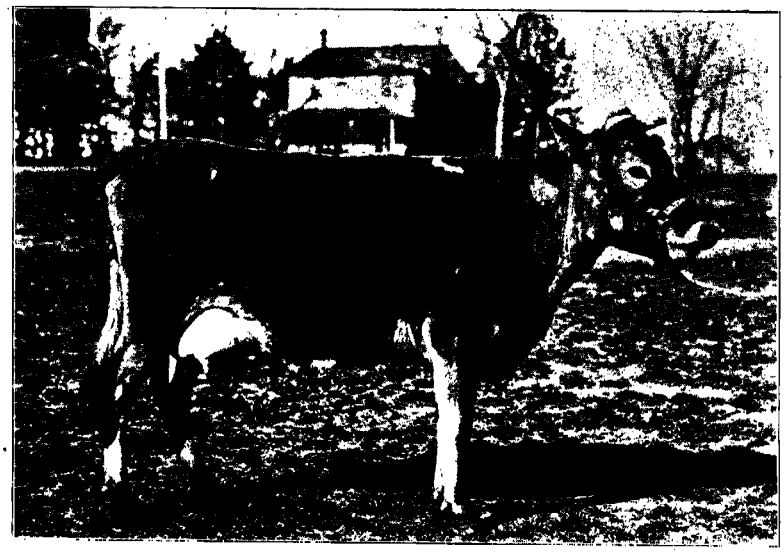

Plate 30. May Queen. Selected by G. W. Priest, Meriden, Kan. Record, 4809.9 pounds of milk and 308.74 pounds of butter-fat in twelve months.

Plate 31. Campbell's King 4951. Guernsey bull used at head of common herd. Record of dam, 600 pounds of butter in one year.

Plate 32 Shylock of Darlington 4579. Guernsey bull used at head of common herd, following Campbell's King. Record of dam, 556 pounds of butter in six months.

Plate 33. Cow No. 47. Half-Guernsey. Sire, Campbell's King; dam, No. 25. Record, 7684.6 pounds of milk; 328.30 pounds of butter-fat.

Plate 34. Cow No. 77. Half-Guernsey. Sire, Campbell's King; dam, No. 4. Record, 7602.6 pounds of milk; 317.64 pounds of butter-fat.

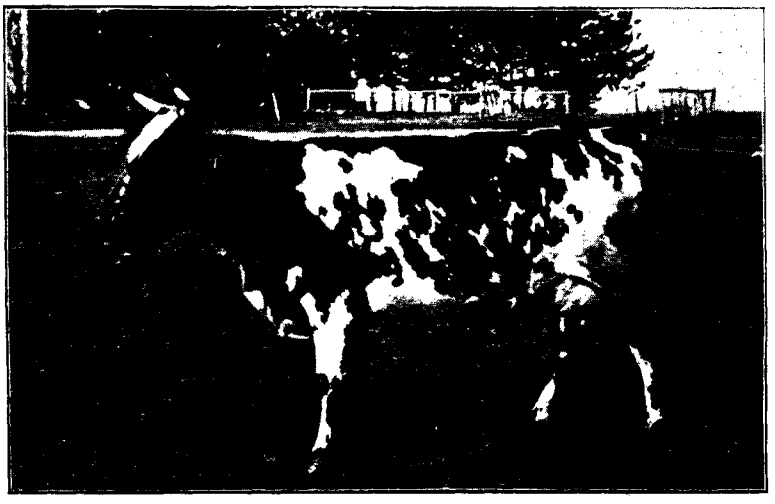

Plate 35. Star of Hillview 11455. Pure-bred Ayrshire cow. Record, 8862.5 pounds of milk; 361.78 pounds of butter-fat.

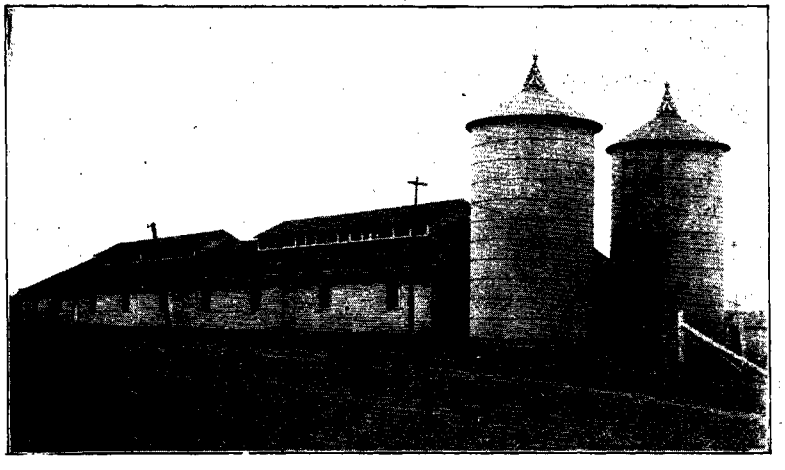

Plate 36. Dairy barn at Kansas Experiment Station.

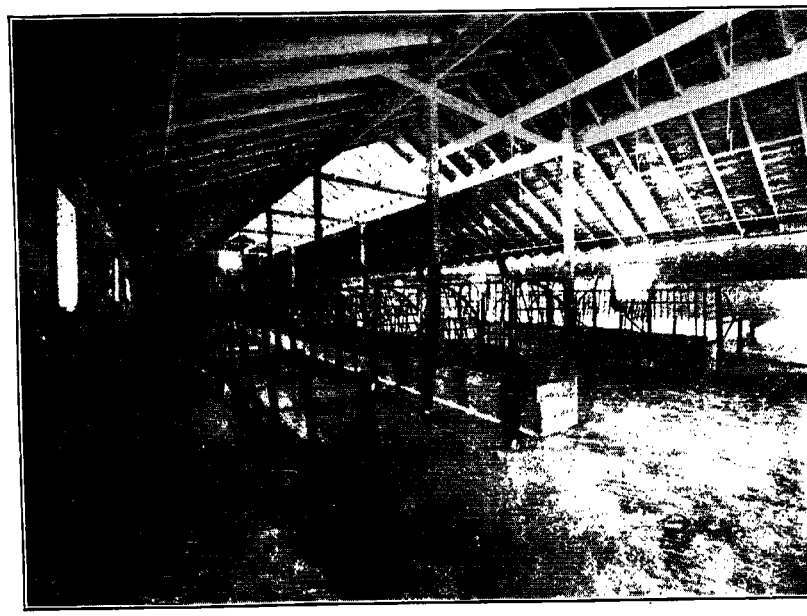

Plate 37. Dairy barn—interior view.

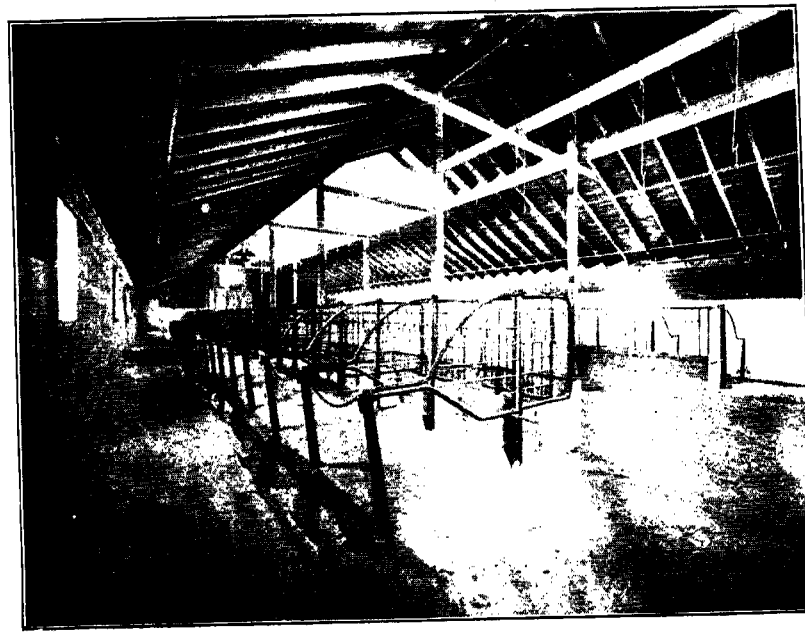

Plate 38. Dairy barn—another view.

Plate 39. Dairy barn—still another view.