



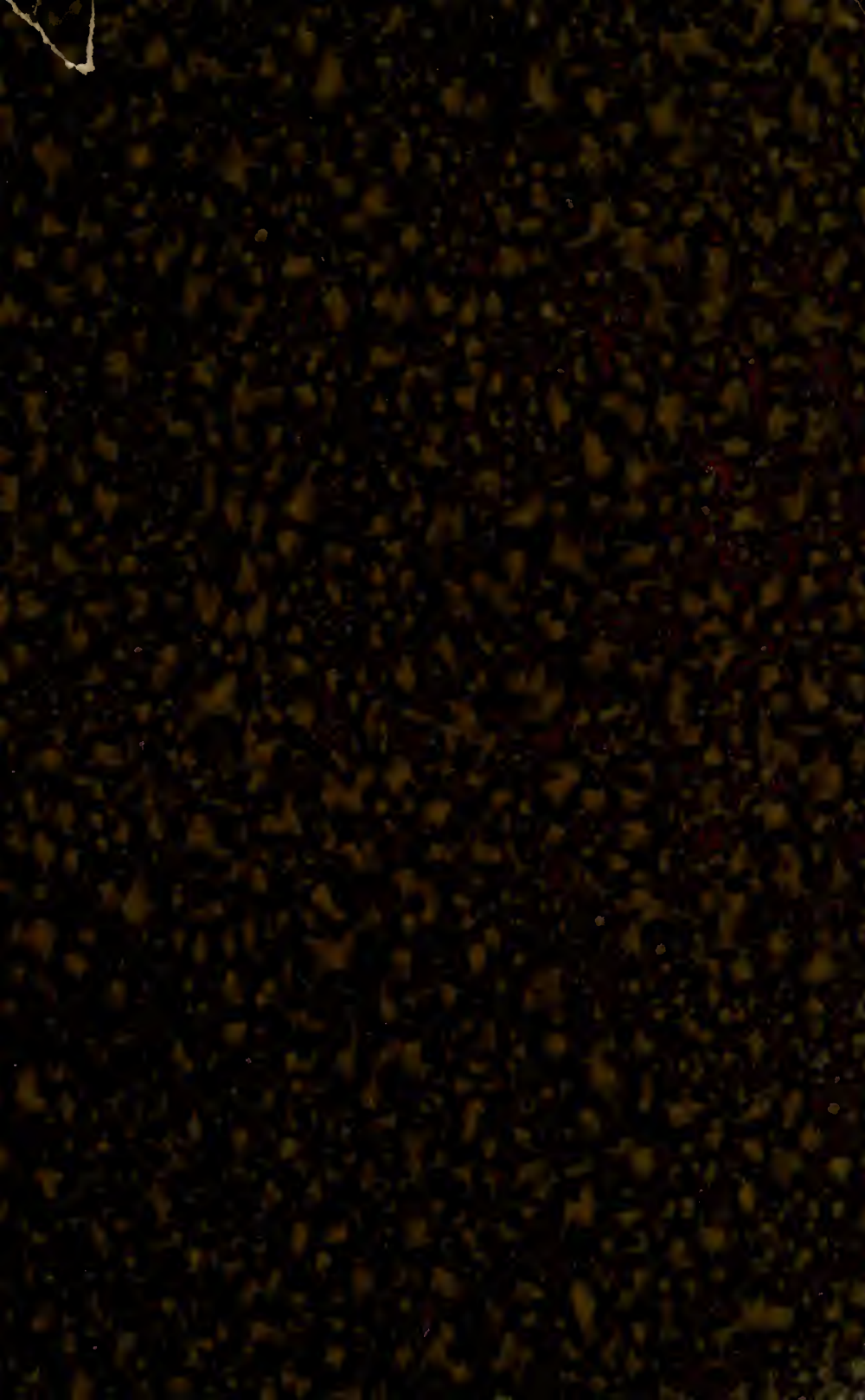
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BULLETIN No. 164

MILK REQUIRED TO RAISE A DAIRY CALF

BY WILBER J. FRASER AND ROYDEN E. BRAND



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MILK REQUIRED TO RAISE A DAIRY CALF

BY WILBER J. FRASER, CHIEF IN DAIRY HUSBANDRY, AND
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INTRODUCTION

One of the greatest problems in successful dairying is to obtain good cows. The fact that every year it is becoming more difficult to buy really efficient producers makes it clear that the surest, most economical, and most satisfactory way to build up an efficient dairy herd, or to keep it supplied with good cows after it is once established, is to raise the heifer calves from the best cows bred to a good pure-bred dairy sire. Furthermore, unless a dairyman raises the heifer calves with which to replenish his herd, it is almost impossible to keep the herd free from tuberculosis and contagious abortion.

Many Illinois dairymen are not raising the heifer calves, even from their best stock but are selling them, good, bad, and indifferent for veal, making no provision for perpetuating their herds or the milking qualities of the best animals in them. These dairymen depend upon buying cows with which to replenish their herds. In the vicinity of Elgin alone, four cow dealers sold 7,000 cows in one year, and, besides this number, many cows were shipped in by the dairymen themselves. But there are few of the best animals for sale, and this means that the dealers cannot get enough really good producers to supply their purchasers. In order that a dairyman may be in the highest degree successful, therefore, he must raise the heifer calves from his best cows. Calf raising should be a part of his business: he has the breeding stock, the feed, and the equipment, and knowing the parentage of the calves, he need save only those from high-producing dams.

A MISTAKEN IDEA

Yet, despite the fact that the evidence is so completely in favor of dairymen raising their heifer calves, hundreds of them defeat their own welfare by making no effort to rear even the best of their heifer calves. Such dairymen imagine that because it re-

quires milk, the practice is too costly in a region where whole milk is sold. In one instance which may be cited from many similar instances, the heifer calves from a cow with an average production of 11,390 pounds of milk and 404 pounds of butter fat per year for three consecutive years, were sold to the butcher as soon as the milk was good. This practice, tho as ruinous to the individual dairyman as to the dairy business as a whole, is only too common in the intensive dairy region of northern Illinois and has led the Department of Dairy Husbandry to undertake an experiment to determine the minimum amount of whole and of skim milk required to raise a calf successfully.

From a brief review of station literature on calf feeding, given on page 458, it will be noticed that none of the experiments conducted at other stations meet the requirements of dairymen in communities where whole milk is sold, as in Illinois. In none of these experiments does it appear that the object was to determine the minimum amount of milk necessary to insure to the calves a satisfactory start in life.

HOW THE EXPERIMENT WAS CONDUCTED

This experiment was divided into three tests, with the calves apportioned into lots, as follows:

First Test	Second Test	Third Test
Lot 1: Nos. 1, 2, 3	Lot 5: Nos. 11, 12, 13	Lot 9: Nos. 23, 24, 25
Lot 2: Nos. 4, 5, 6	Lot 6: Nos. 14, 15, 16	Lot 10: Nos. 26, 27, 28
Lot 3: Nos. 7, 8, 9	Lot 7: Nos. 17, 18, 19	
Lot 4: No. 10	Lot 8: Nos. 20, 21, 22	

The calves were allowed to remain with their dams during the first twenty-four hours, and were then removed and weighed. During the first four days they were fed their mothers' milk according to appetite, care being taken to keep them from overfeeding. After this they were fed whole and skim milk in the amounts shown in the tables. In all cases the milk was fed clean and warm as it came from the separator; had it been allowed to become contaminated or had it been fed cold or sour, digestive trouble would surely have been the result.

As most farmers will not take sufficient trouble to properly use substitutes for milk, if at all, none were used in this experiment. The calves were transferred from milk to a ration composed of grain, clover hay, and pasture, thus making the data acquired more directly applicable to ordinary farm conditions.

The chief economic question that determines whether or not dairymen in Illinois shall raise heifer calves is not the cost of the grain, hay, and pasture which the calves consume, but the amount

of milk that it takes to get them started in life successfully. For this reason no record was kept of the amounts of grain and hay consumed. Furthermore, altho the feeds were weighed to each lot, it was impossible to tell how much was consumed individually at any given age because the calves even within a lot were of different ages and the young ones often slobbered over some of the grain so that it had to be removed.

HOW THE FIRST TEST WAS CONDUCTED

For the first test ten calves were divided into three lots of three calves each; the one remaining calf, No. 10, being fed separately, as shown in Table 1.

These calves were from grade cows in the University herd. Many males were included because not enough heifer calves were available.

Since the object of the experiment was to determine how economically a calf can be successfully raised on whole and skim milk, and since skim milk is the cheaper, some of the calves were given only a small quantity of whole milk, the attempt being made to feed them largely upon skim milk when but a few days old. This deranged the calves' digestion very seriously in some cases.

Table 1 shows the length of time both whole and skim milk were fed to each calf, the amounts fed, and the rapidity with which the change was made from whole to skim milk.

Four of the calves were given only 15 to 21 pounds of whole milk each. Changing so early to skim milk had a tendency to derange their digestions at first, and they did not do well afterwards even tho the skim milk was continued longer than would have been necessary had they been given a better start on whole milk, as was done with Calves Nos. 2, 5, 6, and 10.

In this preliminary work, three calves were entirely cut off from milk at 42, 45, and 46 days of age, respectively. Being obliged to subsist upon grain and hay before their digestive organs were able to take care of this kind of food, the calves developed a feverish condition in their digestive tracts. This gave them an abnormal craving which they tried to satisfy with water, drinking such large amounts that they breathed with great difficulty. Their digestive troubles seemed only to be increased by this excessive amount of water, and later, when the amount given them was limited, rapid improvement was noticeable. Altho these calves were decidedly thin at two months of age, with careful feeding they later developed into good animals, as may be seen from Figs. 1, 2, and 3.

This preliminary work demonstrated in a very striking manner that the most important thing in raising calves is to give them a good start. During the first two weeks of their lives they must be

TABLE 1.—WHOLE MILK, SKIM MILK, AND WATER CONSUMED BY THE CALVES IN THE FIRST TEST
(Amounts Expressed in Pounds)

Age, days	Lot 1						Lot 2						Lot 3						Lot 4		
	Calf No. 1		Calf No. 2		Calf No. 3		Calf No. 4		Calf No. 5		Calf No. 6		Calf No. 7		Calf No. 8		Calf No. 9		Calf No. 10		
	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Water
5	5	6	8	4	4	8	4	9	9	5	2	2	2	1	1	6	1	3	9	9	
6	4	6	8	4	4	8	4	10	10	4	4	2	2	1	7	7	3	9	9	9	
7	4	6	8	4	4	8	4	10	10	4	4	2	2	1	7	7	3	9	9	9	
8	4	6	8	4	4	8	4	10	10	4	4	2	2	1	7	7	3	9	9	9	
9	4	6	9	3	3	9	2	10	10	4	4	2	2	1	7	7	3	9	9	9	
10	4	6	10	2	2	12	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
11	4	6	10	1	1	12	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
12	4	6	10	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
13	4	6	10	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
14	4	7	10	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
15	4	7	9	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
16	4	7	9	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
17	4	7	8	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
18	4	7	8	1	1	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
19	4	7	7	4	4	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
20	4	7	7	5	5	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
21	4	7	6	6	6	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
22	4	7	6	6	6	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
23	4	7	5	7	7	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
24	4	7	4	8	8	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
25	4	7	3	9	9	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
26	3	7	2	10	10	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
27	3	7	1	11	11	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
28	3	7	1	12	12	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
29	3	7	7	12	12	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
30	3	7	7	11	11	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
31	3	7	7	11	11	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	
32	2	8	7	10	10	11	1	10	10	4	4	2	2	1	7	7	3	9	9	9	



FIG. 1. CALF No. 2, Lot 1.

This Calf Received 166 Pounds of Whole Milk and 234 Pounds of Skim Milk; a Total of 400 Pounds. Note Its Thrifty Growing Condition.



FIG. 2. CALF No. 5, Lot 2.

This Calf Received 176 Pounds of Whole Milk and Only 148 Pounds of Skim Milk; a Total of 324 Pounds. Altho Very Thin for a Time, It Was in Good Condition When Seven Months of Age.

fed a reasonable amount of milk containing about 3 percent butter fat. After this, their feed may be gradually changed to skim milk, but until they are about eight weeks old they must still receive practically all of their nourishment in the form of milk. This work demonstrated also that if calves are required to obtain even a portion of their nutriment from grains or hay when they are less than seven weeks old, their digestions will become badly deranged, and that even tho they are continued on a generous amount of skim milk for a considerable length of time, damage has been done from which they will not recover rapidly.

The grain used to supplement the milk fed to one lot of calves was corn alone, and to the other lots, a mixture of grains higher in protein. Previous calf-feeding experiments¹ had shown that corn was a better feed for calves than oil meal or a grain mixture high in protein. This proved to be true only when the calves were given a large amount of skim milk. When the amount of both whole and skim milk was limited, the grain best suited to feeding was found to depend to a considerable extent upon its palatability. When skim milk is no longer fed, of course the ration must contain a large amount of protein if the calves are to thrive upon it.



FIG. 3. CALF NO. 7, LOT 3.

This Calf Received Only 15 Pounds of Whole Milk (1 Pound per Day for 15 Days) and 613 Pounds of Skim Milk. It Did Not Receive Enough Whole Milk the First Two Weeks of Its Life, Yet When Eight Months of Age It Had Grown into Fine, Sleek Condition.

¹Iowa.

The condition of the calves when about seven months old may be seen in Figs 1, 2, and 3, which show one representative calf selected from each lot. All the calves in each lot were doing practically as well between six and eight months of age as those shown in the cuts. It will be noticed that there was a great variation in the amounts of whole and skim milk given these different animals, and yet the calf shown in Fig. 3, which received only 15 pounds of whole milk, made an especially fine growth later in life.

HOW THE SECOND TEST WAS CONDUCTED

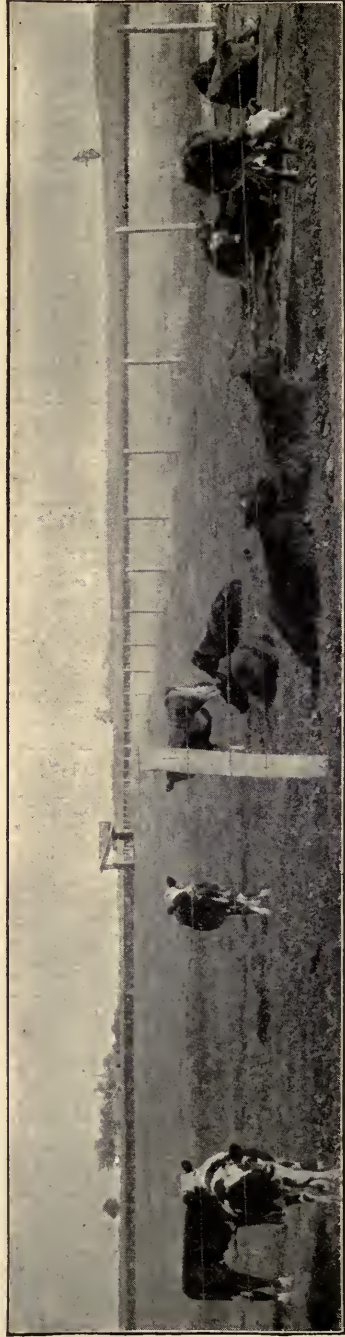
The twelve calves used in the second test were divided into four lots of three calves each. As in the first test, they were fed their mothers' milk until they were 5 days old, care being taken that they should not overfeed. They were then given whole and skim milk in the amounts shown in Table 2 (page 446). With two exceptions, each calf was fed 10 pounds of whole milk and 2 pounds of skim milk per day for about 10 days. By changing one pound per day, the whole milk was then gradually replaced with skim milk, so that at about 25 days of age, the calves were put entirely upon skim milk. They were then fed 12 pounds of skim milk per day for 20 days, or until they were about 45 days old, at which age, according to the original plan, their ration of skim milk was reduced one pound per day until they were 56 days old, after which no milk was fed. This plan was varied from slightly in a few cases, and several of the calves were fed skim milk for 5 days longer, or until they were 61 days old, because they were not doing well at the time. On the whole, the calves in the second test did not have their digestions so badly deranged as those in the first test, and for this reason they did not get into as poor condition.

The grains fed the calves in the second test were as follows:

Lot 5	Lot 6
Whole oats	Whole oats.....1 part
	Ground flaxseed.....2 parts
Lot 7	Lot 8
Whole oats.....4 parts	Same mixture as fed to Lot 7, 1 part
Corn.....4 parts	Ground flaxseed.....2 parts
Bran.....1 part	
Linseed meal.....1 part	

The roughage fed to all four of the lots was good clover hay.

Theoretically, because of its composition, a grain mixture composed largely of ground flaxseed containing the oil would seem to be the ideal feed for calves maintained on skim milk, but it was found in this test that because of its lack of palatability the calves would not consume enough of it, while they ate more freely of the



FIGS. 4 AND 5. SECOND TEST. LOTS 5, 6, 7, AND 8 ON PASTURE. Note Thrifty Condition of These Calves When About Six Months of Age.

TABLE 2.—WHOLE AND SKIM MILK CONSUMED AND WEIGHT OF EACH CALF IN THE SECOND TEST (Expressed in Pounds)

Age, days	Lot 5						Lot 6							
	Calf No. 11		Calf No. 12		Calf No. 13		Calf No. 14		Calf No. 15		Calf No. 16			
	Milk Whole	Milk Skim	Weight of calf	Milk Whole	Milk Skim	Weight of calf	Milk Whole	Milk Skim	Weight of calf	Milk Whole	Milk Skim	Weight of calf		
1	11	1	75	6	2	82	10	2	10	2	82	11	1	86
5	10	2		11	5		10	2	10	2		10	2	
6	10	2		7	7		10	2	10	2		10	2	
7	10	2		8	8		10	2	10	2		10	2	
8	10	2		9	9		10	2	10	2		10	2	
9	10	2		10	10		10	2	10	2		10	2	
10	10	2		10	11		10	2	10	2		10	2	
11	10	2		10	10		10	2	10	2		10	2	
12	10	2		10	10		10	2	10	2		10	2	
13	10	2		10	10		10	2	10	2		10	2	
14	10	2		10	10		10	2	10	2		10	2	
15	10	2	86	10	10		10	2	10	2		10	2	
16	10	2		10	10		10	2	10	2		10	2	
17	7	5		9	9	86	9	3	9	3	100	9	3	99
18	6	6		8	3		8	4	8	4		8	4	
19	5	7		7	5		7	5	7	5		7	5	
20	4	8		6	6		6	6	6	6		6	6	
21	4	9		5	7		5	4	5	4		5	4	
22	3	9		4	8		4	8	4	8		4	8	
23	3	9		3	3		3	3	3	3		3	3	
24	1	12		2	10		2	10	2	10		2	10	
25		12		1	11		1	11	1	11		1	11	
26		12		1	12		1	12	1	12		1	12	
27		12		1	12		1	12	1	12		1	12	
28		12		1	12		1	12	1	12		1	12	

29	105	124	108	116	106	128
30	12	12	12	12	12	12
31	12	12	12	12	12	12
32	12	12	12	12	12	12
33	12	12	12	12	12	12
34	12	12	12	12	12	12
35	12	12	12	12	12	12
36	12	12	12	12	12	12
37	12	12	12	12	12	12
38	12	12	12	12	12	12
39	12	12	12	12	12	12
40	12	12	12	12	12	12
41	12	12	12	12	12	12
42	12	12	12	12	12	12
43	118	141	122	131	114	138
44	12	12	12	12	12	12
45	11	11	11	11	11	11
46	11	10	10	10	10	10
47	8	9	9	9	9	9
48	8	8	8	8	8	8
49	7	8	8	8	8	8
50	6	7	7	7	7	7
51	5	6	6	6	6	6
52	4	5	5	5	5	5
53	3	4	4	4	4	4
54	3	3	3	3	3	3
55	2	2	2	2	2	2
56	1	1	1	1	1	1
57	121	145	136	139	123	151
58	12	12	12	12	12	12
59	12	12	12	12	12	12
60	132	160	148	144	129	161
71						
Total	150 397	162 378	137 444	155 403	155 403	156 402
Gain in weight	57	67	66	62	47	75

31	12											125	111	117
32	12													
33	12													
34	12													
35	12													
36	12													
37	12													
38	12													
39	12													
40	12													
41	12													
42	12													
43	12													
44	12													
45	12													
46	11													
47	10													
48	9													
49	8													
50	7													
51	6													
52	5													
53	4													
54	3													
55	3													
56	2													
57	1													
58														
59	4													
60	8													
61	8													
62	8													
63	8													
64	8													
71														
Total	167	415	157	458	138	452	141	491	141	491	157	481	145	491
Gain in weight	72		64		72		81		63		81		63	

105

112

161

133

121

113

111

125

172

152

134

121

117

135

181

169

141

136

53

63

81

72

64

72

other grains, which they appeared to like much better. This would seem to show that palatability is a more important factor than nutritive value.

Table 3 gives the breeding of each calf, and the condition of dam and calf and the weight of calf at birth. It also shows the amount of whole and skim milk consumed during the first ten weeks of the calf's life, the gain made by each calf, and its weight at the end of the ten weeks. It must be understood that each calf had consumed a small amount of grain and hay by the time it was ten weeks old.

From this table it will be seen that it was found possible to raise calves on a moderate amount of milk; the average amount required being 152 pounds of whole milk and 435 pounds of skim milk. They were rather thin for a time, it is true, but they were kept on pasture with a little grain until about six months of age, when they were all in good, thrifty condition, as shown in Figs. 4, 5, and 6. It will be noticed that they made an average gain of 65 pounds during the first 70 days of their lives, which was doing fairly well for dairy calves.

About half the calves used for this experiment were from grade cows in the University herd; the remainder were borrowed at birth from neighboring dairymen and returned to them at about six months of age. Several of the calves kept by the University developed into good producers.



FIG. 6. CALVES FROM SECOND TEST.
Note Their Fine Condition When About Six Months of Age.

TABLE 3.—BREEDING, CONDITION, WEIGHT, AND GAIN OF THE CALVES IN THE SECOND TEST, AND AMOUNT OF MILK CONSUMED

Calf No.	Breeding		Condition at Birth		Weight at birth, pounds	Weight at 10 weeks, pounds	Gain, pounds	Milk consumed, pounds	
	Sire	Dam	Dam	Calf				Whole	Skim
11	Ayrshire	Gr. Shorthorn	Excellent	Excellent	75	132	57	150	397
12	Holstein	Gr. dairy cow	Very poor	Fair	93	160	67	162	378
13	Guernsey	Jersey	Good	Fair	82	148	66	137	444
14	Guernsey	Gr. dairy cow	Excellent	Excellent	82	144	62	155	403
15	Ayrshire	Gr. Holstein	Excellent	Excellent	82	129	47	155	403
16	Guernsey	Holstein	Excellent	Excellent	86	161	75	156	402
17	Jersey	Jersey	Fair	Thin but healthy	64	136	72	167	415
18	Hereford	Gr. dairy cow	Fair	Good	77	141	64	157	458
19	Guernsey	Gr. Shorthorn	Excellent	Excellent	97	169	72	138	452
20	Ayrshire	Gr. Holstein	Excellent	Excellent	100	181	81	141	491
21	Jersey	Jersey	Fair	Good but delicate	72	135	63	157	481
22	Hereford	Gr. Holstein	Thin but healthy	Weak	64	117	53	145	491
Average.....					81	146	65	152	435

HOW THE THIRD TEST WAS CONDUCTED

The six calves in the third test were divided into two lots of three calves each. Most of these calves were given more whole milk than those in the previous tests in an attempt to give them a better start before putting them on a skim-milk ration. The length of time both whole and skim milk were fed each calf, the amounts fed, and the rapidity with which the change was made from whole to skim milk may be seen from Table 4.

It will be noted that Calf No. 23 received 220 pounds of whole milk. While it is true that these calves had a somewhat better start than those in the first and second tests, it was found that when whole milk is high priced, it is ordinarily not necessary to feed a healthy calf more than 150 to 170 pounds before changing the ration to skim milk, if care is exercised to have the milk warm, sweet, and clean, and if the change from whole to skim milk is made gradually, as was done with Calves Nos. 24, 25, 27, and 28. These calves were always healthy, and while they were rather thin from the time they were eight to twelve or fifteen weeks old, they grew into good condition later and made fine, healthy heifers.

Thus the belief that calves could be successfully raised on approximately 150 pounds of whole milk and 450 pounds of skim milk has been confirmed by this third test.

TABLE 4.—WHOLE AND SKIM MILK CONSUMED BY THE CALVES IN THE THIRD TEST (Amounts Expressed in Pounds)

Age, days	Lot 9						Lot 10					
	Calf No. 23		Calf No. 24		Calf No. 25		Calf No. 26		Calf No. 27		Calf No. 28	
	Milk		Milk		Milk		Milk		Milk		Milk	
	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim
5	13		13		13		13		13		13	
6	13		13		13		13		13		10	2
7	13		10	2	10	2	13		10	2	10	2
8	13		10	2	10	2	13		6	2	10	2
9	13		10	2	10	2	13		10	2	10	2
10	13		6	2	10	2	13		10	2	10	2
11	13		10	2	10	2	10	2	10	2	10	2
12	13		10	2	10	2	10	2	10	2	10	2
13	13		10	2	10	2	10	2	10	2	10	2
14	10	2	10	2	10	2	6	2	10	2	10	2
15	10	2	10	2	10	2	10	2	9	3	10	2
16	10	2	10	2	10	2	10	2	10	2	9	3
17	6	2	9	3	9	3	10	2	9	3	8	4
18	10	2	8	4	8	4	10	2	8	4	7	5
19	10	2	7	5	7	5	10	2	7	5	6	6
20	10	2	6	6	6	6	10	2	6	6	5	7
21	10	2	5	7	5	7	9	3	5	7	4	8

TABLE 4.—Continued

Age, days	Lot 9						Lot 10					
	Calf No. 23		Calf No. 24		Calf No. 25		Calf No. 26		Calf No. 27		Calf No. 28	
	Milk		Milk		Milk		Milk		Milk		Milk	
	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim	Whole	Skim
22	10	2	4	8	4	8	8	4	4	8	3	9
23	10	2	3	9	3	9	8	5	3	9	2	10
24	9	3	2	10	2	10	6	6	2	10	1	11
25	8	4	1	11	1	11	5	7	1	11		12
26	7	5		12		12	4	8		12		12
27	6	6		12		12	3	9		12		12
28	5	7		12		12	2	10		12		12
29	4	8		12		12	1	11		12		12
30	3	9		12		12		12		12		12
31	2	10		12		12		12		12		12
32	1	11		12		12		12		12		12
33		12		12		12		12		12		12
34		12		12		12		12		12		12
35		12		12		12		12		12		12
36		12		11		12		12		11		12
37		12		10		12		12		12		12
38		12		9		12		12		12		12
39		12		12		12		12		12		12
40		12		12		12		11		12		12
41		12		12		12		10		12		12
42		12		12		12		9		12		12
43		11		12		12		12		12		12
44		10		12		12		12		12		12
45		9		12		12		12		12		11
46		12		11		12		12		11		10
47		12		10		11		12		10		9
48		12		10		10		12		9		8
49		12		9		9		12		8		7
50		12		8		8		11		7		6
51		12		7		7		10		6		5
52		12		6		6		10		5		4
53		11		5		5		9		4		3
54		10		4		4		8		3		2
55		10		3		3		7		2		1
56		10		2		2		6		1		
57		9		1		1		5				
58		8						4				
59		7						3				
60		6						2				
61		5						1				
62		4										
63		3										
64		2										
65		1										
Total	258	403	167	394	171	401	220	393	166	389	158	389

SUMMARY AND CONCLUSIONS

To summarize the results of the different tests, Table 5 was compiled giving the total amount of whole milk, the total amount of skim milk, and the total amount of both whole and skim milk consumed by each of the calves in the three tests.

THE FIRST TEST

From Table 5 it will be seen that five of the ten calves in the first test were given only 15 to 40 pounds of whole milk each and 545 to 613 pounds of skim milk, and that the total amount of both whole and skim milk ranged from 563 up to 646 pounds. As this experiment was intended to apply to conditions where skim milk, as well as whole milk, is scarce or high priced, the other five calves in the first test were given from 108 to 176 pounds of whole milk and from 148 to 363 pounds of skim milk.

It will be noticed that Calf No. 10 received a total of only 319 pounds of milk. Altho this calf was fed too small an amount of milk and was entirely cut off from milk before it had reached the age at which it could digest grain and hay properly, it finally grew into good condition, but for a time it was in poorer condition than it is wise to permit.

The conclusion to be drawn from this preliminary work is that it is necessary to give the calves a fairly good start on whole milk and also to feed them a reasonable amount of skim milk until they are about eight weeks of age.

THE SECOND TEST

The calves in the second test, Nos. 11 to 22 inclusive, were fed from 137 to 167 pounds of whole milk and from 378 to 491 pounds of skim milk. This feeding proved to be much more rational, as is shown by the fact that the calves in this test had less trouble with their digestions and did much better than most of those in the first test. The total amount of milk given each of these calves varied from 540 to 638 pounds. This proved to be quite ample to raise a calf successfully.

THE THIRD TEST

The calves in the third test, Nos. 23 to 28 inclusive, in some cases were fed somewhat more liberally, especially of whole milk, than those in the second test, but they did not do much better. The results of these second and third tests would therefore seem to show

TABLE 5.—AMOUNT AND VALUE OF MILK CONSUMED BY EACH CALF
IN THE EXPERIMENT

Calf No.	Milk consumed, pounds			Cost of milk fed each calf (skim milk at 25c per 100 pounds; whole milk at values given below)				
	Whole	Skim	Total	\$1.00	\$1.20	\$1.40	\$1.60	\$1.80
First Test								
1	108	363	471	1.99	2.20	2.42	2.64	2.85
2	166	234	400	2.25	2.58	2.91	3.24	3.57
3	18	545	563	1.54	1.58	1.61	1.65	1.69
4	17	550	567	1.55	1.58	1.61	1.65	1.68
5	176	148	324	2.13	2.48	2.83	3.19	3.54
6	140	361	501	2.30	2.58	2.86	3.14	3.42
7	21	606	627	1.72	1.76	1.81	1.86	1.90
8	15	613	628	1.68	1.71	1.74	1.77	1.80
9	40	606	646	1.92	2.00	2.08	2.16	2.24
10	117	202	319	1.68	1.91	2.14	2.38	2.61
Second Test								
11	150	397	547	2.49	2.79	3.09	3.39	3.69
12	162	378	540	2.57	2.89	3.22	3.54	3.86
13	137	444	581	2.48	2.75	3.03	3.30	3.57
14	155	403	558	2.56	2.87	3.18	3.49	3.80
15	155	403	558	2.56	2.87	3.18	3.49	3.80
16	156	402	558	2.57	2.88	3.19	3.50	3.81
17	167	415	582	2.71	3.04	3.38	3.71	4.04
18	157	458	615	2.71	3.03	3.34	3.66	3.97
19	138	452	590	2.51	2.79	3.06	3.34	3.61
20	141	491	632	2.64	2.92	3.20	3.48	3.77
21	157	481	638	2.77	3.09	3.40	3.71	4.03
22	145	491	636	2.68	2.97	3.26	3.55	3.84
Third Test								
23	258	403	661	3.59	4.10	4.62	5.14	5.65
24	167	394	561	2.66	2.99	3.32	3.66	3.99
25	171	401	572	2.71	3.05	3.40	3.74	4.08
26	220	393	613	3.18	3.62	4.06	4.50	4.94
27	166	389	555	2.63	2.96	3.30	3.63	3.96
28	158	389	547	2.55	2.87	3.18	3.50	3.82
Average								
	134	422	557	2.40	2.67	2.94	3.21	3.48

that the important thing in the raising of calves is to give them a fairly good start on whole milk during the first three weeks, and that after this, whole milk may be successfully replaced with skim milk if the skim milk is fed sweet and warm as it comes from the separator. The calves should be continued on 12 pounds of skim milk a day until they are about seven weeks old, and thereafter the amount may be rapidly reduced, so that by the time they are about eight weeks old they will be receiving no milk at all. At this age their digestive organs have normally reached a stage of development which permits the feeding of grain and hay without causing serious digestive disorders.

There is a lack of sufficient data from which to draw absolute conclusions regarding the amount of milk required to raise a calf. Where it is possible, more milk than herein recommended should be fed, as it is always best to keep a calf in a good growing condition from its birth to maturity.

It should be borne in mind that alfalfa hay is a most excellent feed for calves. If the calves in these tests could have had a good supply of choice alfalfa hay, they would have been greatly benefited. Every farmer should raise at least a small amount of alfalfa hay if for no other purpose than to feed to his calves

COST OF MILK FED EACH CALF

The remaining portion of Table 5 deals with the cost of milk fed each calf when skim milk is worth 25 cents per hundred pounds and the value of whole milk varies from \$1 to \$1.80 per hundred pounds, on the farm.

It will be noted that with whole milk at \$1.40 per hundred pounds, the value of the total milk consumed per calf varied from \$1.61 to \$4.62. This value is comparatively small, and yet at six months of age every one of the twenty-eight calves was in good condition.

WHY IT PAYS TO RAISE HEIFERS

The figures in Table 5 show that the cost of the milk required to raise a calf successfully is not excessive. Experienced dairymen say that the heifers they raise from their best cows produce as much during their first lactation period as do the average mature cows they can buy. The Department of Dairy Husbandry has weighed and tested the milk of a large number of individual cows in the dairy herds over the state, thus obtaining their yearly production, and they find that the average annual production of the cows in the herds where grading has not been practiced is 177.6 pounds of butter fat, making an annual profit of \$5.33 per cow, while the

average annual production of the cows in herds where grading has been practiced is 263 pounds of butter fat, making an annual profit of \$25.86 per cow. This means that the average cow in the herds where grading has been practiced earns for her owner \$20.53 more annually than the average cow in the herds where grading has not been practiced, or practically five times as much.

This annual advantage of \$20.53 to offset the care, trouble, and cost of raising the heifers from the best cows, makes evident at once the fallacy of the belief that milk at the market price is too expensive to feed even good calves. If one considers that \$20.53 is equal to five-percent interest on \$410, it certainly makes the cost of the milk required for the calf (\$4.62) look very insignificant.

BRIEF STATEMENT OF SOME CALF-FEEDING EXPERIMENTS OF OTHER STATIONS

1. Substitutes for Skimmed Milk in Raising Calves. E. S. Savage and W. G. Tailby, Jr., New York (Cornell) Bul. No. 304, 1911. (A comparison of skim milk and Schumacher's calf meal, Blatchford's calf meal, and Lacentia Suisse, a foreign calf meal.)

2. Raising Calves (for beef) on Separator Milk. H. T. French, Idaho Bul. 48, 1905.

3. Upon Skim Milk as a Food for Calves. C. S. Plumb. Ind. Bul. 47, 1893.

4. Calf Feeding Experiment. J. Wilson, G. E. Patrick, C. F. Curtiss, and D. A. Kent. Iowa Bul. 14, 1891. (A comparison of whole milk and a combination of skim milk and ground flaxseed.)

5. Experiments with Hand-fed Calves. D. H. Otis. Kan. Bul. 126, 1904. (A comparison of calves nursing dams with calves fed whole and skim milk.)

6. Feeding Experiments with Calves. J. B. Lindsey. Mass. State Report for 1894, pp. 125-145. (Skim milk and various oils used as feed.)

7. Rearing Calves on Skim Milk and Supplementary Feed. H. W. Norton, Jr. Mich. Bul. 257, 1909. (An experiment in raising calves for beef and dairy purposes on whole milk and on skim milk supplemented with hay, roots, green feed, and grain.)

8. Raising Dairy Bred Calves. T. L. Haecker. Minn. Bul. 35, 1894. (A comparison of whole milk and skim milk supplemented by flaxseed meal.)

9. Feeding Experiments with Calves. Miss. Report for 1888, p. 43. (A comparison of the value of eight pounds of whole milk with that of an unlimited quantity of skim milk, and with ten pounds of skim milk and Blatchford's calf meal.)

Miss. Report for 1904, pp. 14, 15. (An experiment in raising calves on skim milk, cotton-seed meal, wheat bran, and cotton-seed hulls.)

10. A Test of Calf Rations. A. L. Haecker. Neb. Bul. 87, 1905. (A comparison of calves fed skim milk supplemented by grain with calves nursing dams.)

11. The Cost of Raising Calves. F. W. Morse. N. H. Bul. 58, 1898. (Calves raised on skim milk and flaxseed jelly.)

12. Feeding Experiments with Calves. H. Hayward. Penna. Report for 1902, pp. 303-313. (A comparison of two home-made substitutes for milk, and skim milk.)

13. By-Products of the Dairy. (a) Experiments in Pig Feeding. (b) Experiments in Calf Feeding. F. B. Linfield. Utah Bul. 57, 1898. (A comparison of whole milk and skim milk for raising and fattening calves for veal.)

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