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ANIMAL-HUSBANDRY DEPARTMENT.

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Experiments with Hand-fed Calves.

WITH the advent of creameries, skimming stations, and hand separators, the question of successful and economical raising of calves on skim-milk is one of growing importance and vital concern to every creamery patron and private dairyman. As land increases in value, we can no longer afford to keep a cow the entire year for raising one calf to be used as a feeding steer.

For the last four years the Kansas Experiment Station has almost continuously been conducting experiments in rearing and feeding calves on skim-milk or substitutes for skim-milk. The material given in this bulletin is the result of our experience.

CARE OF THE COW BEFORE CALVING. Strong, thrifty calves cannot be expected from cows that have received poor feed and poor care previous to calving time. The cow must be supplied with wholesome and nutritious feed, containing the elements that are necessary to the proper development of bone and muscle in the fetus. It is better for the cow, and we believe better for her record in the production of milk and butter-fat, if she can go dry for six or eight weeks previous to calving. If it is impossible to dry her up without injuring the udder, continuous milking should be practiced.

*Credit is due the following graduates and special students, who took a keen interest in attending to the feed and care of the calves used in the experiments recorded in this Bulletin: J. A. Conover, H. M. Bainer, A. L. Cottrell, E. B. Patten, F. E. Uhl, L. S. Edwards, Geo. C. Wheeler, Jesse M. Jones, and W. N. Birch.

Where the cow has access to good pasture with plenty of spring-water she needs little or no attention until two or three days before calving. If she has secluded, shady and otherwise comfortable quarters separate from the other cattle, and is carefully watched by an attendant, she may need no other attention until after the calf is dropped. Sometimes luxuriant pastures will stimulate heavy milkers to produce too much milk prior to calving, in which case the supply of feed should be reduced, and in extreme cases the milk removed before calving.

When kept on dry feed care should be taken to provide plenty of succulence. Ensilage and roots serve an excellent purpose, the object being to keep the bowels loose. When alfalfa or clover hay is used for roughness very little grain is necessary. With less nitrogenous rough feeds, a grain mixture of two-thirds bran and one-third oil. meal is excellent. Soy beans may be used as a substitute for oil-meal.

CARE OF COW AND CALF AT CALVING. In cool or cold weather the cow should be placed in a box stall, well lighted, with plenty of ven. tilation. When the calf is dropped it is well to blanket the cow until she regains her normal condition. In the absence of anything better, gunny-sacks sewed together will do very well. Light, loosening feeds, water from which the chill has been taken off, should be given. Cold water is liable to cause contraction of the womb and retention of the afterbirth. If the latter is not discharged in from twenty-four to forty-eight hours it should be removed. If the udder is heated and caked it is advisable to milk the cow frequently, though not quite dry, and the udder should be steamed by rubbing with a flannel cloth dipped in as hot water as the hand will bear, after which the udder should be rubbed dry, and treated with camphor, olive oil, or camphorated vaseline. If there are any signs of constipation, it is well to administer from one and one-half to two pounds of Epsom salts dissolved in water. All these points will aid materially in keeping the cow in a good, healthy condition, and consequently give the calf a good, healthy start.

As soon as the calf is licked dry by its mother, it should have strength enough to rise and suck; if it has not, it should be assisted. The calf may be taken away from its mother after its first meal, or, if preferred, can be left with the cow until the milk is good. It is easier to teach the calf to drink if it is taken away early. Our experience is that if the calf is taken away at once, or when four or five days old, it will make good gains the first week, but if left two or three weeks, the first seven days after weaning will be a losing period. If the cow's udder is caked it is desirable to leave the calf with her, as the rubbing of the calf tends to alleviate the inflammation.

FEEDING MILK AND SKIM-MILK.

BREAKING THE CALF TO DRINK. It is well to leave the calf by itself for at least twelve hours and, in case the calf has run with its mother for several days, possibly twenty-four hours. Attempts to feed the calf earlier than this usually do the calf no good and may injure the feeder's temper. If the calf's muzzle is held in the milk and its mouth pried open once, so that it tastes the milk, our experience tells us that the calf can be taught to drink without the feeder being obliged to place his hand in the milk and allow the calf to suck his finger — an unpleasant experience in winter weather.

This Station has had some experience with calf-feeders, which consist of a rubber nipple and tube, the latter fastened at a convenient height for the calf to reach, and the tube placed in the milk-pail. The manufacturers of these feeders claim that a calf can be taught to feed itself easier, and that it does not gulp its milk down as when drinking out of a pail. Our experience indicates that the first point is not well taken; that it is as easy, if not easier, to teach the calf to drink without the feeder. With the feeder the calf loses the nipple, and is unable to find it without assistance from the attendant. As to rapid drinking the statement is all too true — so much so, that in cold weather the milk will become entirely too cold before the calf can consume it through the feeder. The feeder is difficult to keep clean, and a person will need a dozen in order to keep himself busy feeding calves. Four to five buckets will keep one man busy. We weighed our calves under experiment once every week, and found that there was no difference in gains between those which consumed their milk slowly through the calf-feeder and those which consumed it rapidly from the pail.

THE NECESSITY OF FEEDING SOME WHOLE MILK. The calf is unable to handle hay or grain until it is a week or ten days old. During this period it is not wise to try to feed skim-milk. At first the whole milk should be fed three times a day — four pounds in the morning, two pounds at noon, and four pounds at night, at blood temperature. In about a week or ten days the calf can be fed twice daily. During this time the allowance of whole milk can be gradually increased to about twelve pounds. The amount depends somewhat on the individuality of the calf and its ability to handle increased quantities.

CHANGING FROM WHOLE TO SKIM-MILK. The stomach of the young calf is very delicate, and all changes should be made gradually. When about two weeks old, the calf, if a strong, vigorous one, can be gradually changed to skim milk. During the first day decrease the amount of the whole milk one pound and add one pound

of skim-milk, and so on each day until the change is complete. Previous to this the calf should have a little grain (corn or Kafir-corn meal, or a mixture of both) placed in its mouth immediately after drinking its milk. In this way it gets a taste of the grain and will soon go to the feed-boxes and eat with a relish.

After the change to skim-milk is completed the amount may be gradually increased as fast as the calf is able to consume it without scouring. Care must be taken not to increase too rapidly, The calf is a greedy animal, and will appear more hungry after drinking its milk than before, and if given too much it will soon be on the sick-list. The milk fed should be weighed or measured at each feeding. Our experience has been that a calf from three to five weeks of age can be fed from ten to twelve pounds daily; from seven to eight weeks old, fourteen to sixteen pounds, and when from three to five months of age can be fed eighteen to twenty pounds of milk. The milk should always be fed warm and sweet. Next to overfeeding, there is probably nothing which causes greater difficulty with hand-fed calves than feeding sweet milk one meal and sour milk the next.

THE IMPORTANCE OF SKIM-MILK. Skim-milk has all the ingredients of whole milk except the fat, as is shown in tables I and II.

TABLE I.—Composition of skim-milk and whole milk compared.

INGREDIENTS.	Skim-milk, general average, (Cooke.)	Whole milk. (Babcock.)
Water	90.25 %	87.17 %
Ash	.80	.71
Casein and albumen	3.50	3.55
Sugar	5.15	4 88
Fat	.30	3.69

TABLE II.—Digestible nutrients, per cent.—skim-milk, whole milk. (From Henry's "Feeds and Feeding.")

	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.		
		Protein.	Carbohydrates.	Ether extract.
Skim-milk	9.4	3.9	5.2	0.3
Whole milk	12.8	3 6	4.9	3.7

It will be seen in table II that the percentage of protein in skim-milk is greater than in whole milk, and as protein is what produces bone and muscle, the feeding value of skim-milk is apparent. The fat taken from the skim-milk can be readily supplied in the fat and starch contained in grains. The fat in the milk would go to keep up the animal heat and be deposited in the system. This makes the calf

receiving whole milk look plumper and slicker, but no better developed in bone and muscle. Comparing the different experiments that we have conducted in feeding calves on skim-milk, table III has been constructed. In figuring for this table, the calves have been charged with grain at fifty cents per hundredweight and hay at four dollars per ton.

TABLE III.—Money value of skim-milk.

Experiment No.	Number of calves.	Value of skim-milk per cwt.		
		When calves are worth $3 per cwt.	When calves are worth $4 per cwt.	When calves are worth $5 per cwt.
I	10	$0.24	$0.32	$0.41
II	10	.20	.32	.43
III	10	.24	.36	.49
IV	10	.19	.32	.44
V	10	.16	.27	.38
VI	10	.21	.35	.47
VII	10	.21	.35	.48
VIII	10	.23	.37	.50
IX	10	.17	.29	.41
X	10	.12	.22	.32
XI	10	.17	.29	.41
XII	10	.15	.27	.38
XIII	10	.21	.34	.47
Average..	10	$0.19	$0.31	$0.43

Table III makes a remarkable showing for skim-milk. With calves worth only $3 per hundredweight, skim-milk is worth nearly 20 cents per hundredweight: with calves at $4 per hundredweight, it is worth 30 cents; and at $5 per hundredweight, over 40 cents.

On account of its superior feeding value, skim-milk should be handled and fed with considerable care. Where milk is delivered to a creamery or skimming station, it is a frequent practice to sterilize it by heating to a high temperature, which process destroys the germs. This is to be highly commended, but some care must be exercised in handling this heated milk. Too frequently a can of skim milk is brought home and set in a tub of cold water, with the expectation of cooling down sufficiently to keep from souring. The result is, that the heated milk heats up the water, and the water cools the milk, and both become in what is known as a lukewarm condition, which furnishes ideal conditions for the development of the souring germs. If hot milk is set in cold water, it should be running water; at least, the water should be changed and the milk stirred sufficiently to cool the latter. By far the best plan is to run the milk over the cooler and then set the cool milk in cold water to keep it cool. Skim-milk treated in this way has

been kept from Saturday noon until Monday morning in good condition during the hottest weather of July and August.

CREAMERY VS. HAND-SEPARATOR SKIM-MILK. With the advent of the hand separator, the question is often asked as to the relative merits of skim-milk from the creamery and from the hand separator. A test comparing the two was made at this Station with thirteen calves, results of which are shown in table IV.

TABLE IV.— Test of sterilized creamery and hand separator skim-milk.

	Number of calves.	Days fed.	Average gains per head.	Daily gain per head.
Sterilized creamery skim-milk.....	6	142	250	1.760
Hand-separator skim-mlik	7	142	251	1.767

At first the calves showed a dislike to the odor of the sterilized skim-milk, but they soon became accustomed to it and drank it readily. From the above table, it will be seen that there was practically no difference between the two classes of skim-milk. It should be stated, however, that the creamery took pains to thoroughly sterilize the milk, and was careful not to receive sour milk that would give it a tendency to clabber. The hand-separator skim-milk was fed immediately after separation. Observations show that the calves receiving sterilized skim-milk were less subject to scours.

EFFECT OF STERILIZING SKIM-MILK. The amount of water added when heating skim-milk by steam is shown in table V.

TABLE V.—Showing amount of water added to skim-milk in the process of sterilization.

		Sterilization temp., F.	Lactometer reading of unsterilized skim-milk.	Lactometer reading of sterilized skim-milk.	Percentage water.	Weather.
Test No. 1. By weighing.	Pounds of whole milk separated..... 2,948 Pounds of skim-milk separated..... 2,675 Pounds of skim-milk after being sterilized..... 3,010 Water added to milk, 335 pounds, or 11 per cent.					
		Degrees.				
Test No. 2. With lactometer.	1	180	36.3	32.0	12	Cool, but not cold.
	2	180	37.5	33.0	12	Cool, but not cold.
	3	180	37.0	32.0	13.5	A cold day.
	4	202	37.0	32.5	12.2	Very cold day.
	5	204	36.0	31.0	13.9	Cold wind blowing.

From the above table, it will be seen that in the process of sterilization with live steam there is from eleven to fourteen per cent. of

TABLE VI.—Summary of results obtained in feeding calves on skim-milk.

Lots.	Number of calves.	Days fed.	Grain fed.	Roughness fed.	Average gains.		Feed consumed per 100 pounds gain.		
					Per head.	Daily per head.	Milk.	Grain.	Roughness.
Skim-milk lot	10	150	Kafir-corn meal, corn-meal	Alfalfa	206.5	1.37	1,197.85	135.88	31.04
Corn-chop lot	10	133	Corn chop	Alfalfa, mixed hay, prairie hay	212.3	1.59	880.56	167.71	333.39
Shelled-corn lot	10	133	Shelled corn	Alfalfa, mixed hay, prairie hay	232.2	1.74	773.04	112.47	365.25
Ground Kafir-corn lot	10	112	Ground Kafir-corn	Alfalfa, prairie hay, orchard-grass	177.7	1.58	829.93	72.78	491.16
Whole Kafir-corn lot	10	112	Whole Kafir-corn	Alfalfa, prairie hay, orchard-grass	162.1	1.44	901.91	101.23	523.68
Blachford's sugar and flaxseed lot	10	105	Shelled corn, ground Kafir-corn, Blachford's sugar and flaxseed	Prairie hay, alfalfa	186.7	1.77	726.16	144.89	375.46
Dried-blood lot	10	105	Shelled corn, ground Kafir-corn, dried blood	Prairie hay, alfalfa	177.5	1.69	750.16	119.91	415.06
Check lot (1)	10	105	Shelled corn, ground Kafir-corn	Prairie hay, alfalfa	186.3	1.77	726.91	112.50	384.05
Rennet lot	10	140	Shelled corn, ground Kafir-corn	Prairie hay, alfalfa, oat hay, mixed hay	193.0	1.37	835.25	119.06	483.76
Reduced-grain-ration lot	10	140	Shelled corn, ground Kafir-corn	Tame hay, prairie hay, alfalfa, oat hay, mixed hay	160.9	1.14	1,006.77	107.12	637.14
Check lot (2)	10	140	Shelled corn, ground Kafir-corn	Prairie hay, alfalfa, oat hay, mixed hay	188.5	1.34	875.11	122.86	405.51
Mixed-grain lot	10	126	Shelled corn, ground Kafir-corn, bran, oats, oil-meal, dried blood	Prairie hay, alfalfa	220.2	1.74	880.19	192.94	333.37
Check lot (3)	10	126	Shelled corn, ground Kafir-corn	Prairie hay, alfalfa	255.1	2.02	772.86	164.75	325.63
Average	10	125.15			196.85	1.58	858.20	124.16	387.26

water added. The amount of water added is usually in proportion to the degree of heat to which the milk is raised. It also varies with the weather, requiring more steam to heat the same amount of milk to a given point on a cold day than on a warm day.

RESULTS WITH SKIM-MILK. The lots of calves fed on skim-milk in the different experiments are grouped in table VI. This table not only shows the possibilities in raising calves on skim-milk, but it also shows the variations in the results obtained. It will be noticed that with young calves it requires a very small amount of feed to produce a pound of gain. (See fig. 1.)

THREE FORMS OF FEEDING MILK COMPARED. Twenty head of grade Short-horn and Hereford calves purchased by the Kansas Experiment Station in the spring of 1900 were divided into two lots as nearly equal as possible. One lot was fed on sterilized creamery skim-milk with a grain ration of equal parts of corn and Kafir-corn meal, with all the alfalfa hay they would eat. The second lot was fed the same as the first, except that fresh whole milk was substituted for skim-milk. To compare with these two lots, the Station secured the privilege of weighing twenty-two head of high-grade Hereford calves which were running with their dams in a pasture near by. A summary of the results is shown in table VII.

TABLE VII.

EXPERIMENT.	Number of calves.	Days fed.	Average gain per head.	Daily gain per head.
Skim-milk	10	154	233	1.51
Whole milk	10	154	287	1.86
Running with dams	22	140	248	1.77

Figuring skim-milk at fifteen cents per 100 pounds and whole milk at creamery prices for butter-fat (which during the past year was 21.08 cents at the College creamery), grain at fifty cents per 100 pounds, and hay at four dollars per ton, the cost of raising these calves is as follows, the value of the skim-milk in the whole milk consumed by the calves being left to balance the expense of hauling:

TABLE VIII.—Cost of raising calves.

	Cost per head.	Cost per 100 pounds gain.
Skim-milk lot	$5 27	$2 26
Whole-milk lot	19 13	7 06
Lot with dams	12 00	4 41

This experiment shows that the feed-cost of raising a good skim-milk calf need not exceed $5.27, in contrast to $19.13 for whole milk

and $12 for one raised by the dam. (See figs. 2 and 4.) A skim-milk calf becomes accustomed to eating grain and roughness early in life, becomes gentle, and when transferred to the feed-lot is ready to make economical gains. At the close of this experiment, the calves running with the dams were purchased by the Experiment Station and placed in the feed-lots in comparison with those raised on skim-milk and whole milk. The results in the feed-lots are shown in table IX.

TABLE IX.

EXPERIMENT.	Number of calves.	Months fed.	Average gain per head.	Daily gain per head.
Skim-milk	10	7	440	2.10
Whole milk	10	7	405	1.93
Running with dams	22	7	422	2.00

It will be seen that the skim-milk calves made the best gains. The feed records show that the skim-milk calves produced 100 pounds of gain for 439 pounds of grain, while the whole-milk calves required 470 pounds of grain per 100 pounds of gain, and the calves running with the dams required 475 pounds of grain per 100 pounds of gain.

Up to weaning time the calves running with their dams looked slicker and fatter than those raised on either skim-milk or whole milk. The critical period with the calves running with the dams was at weaning time. This is shown in table X.

TABLE X.—Gains and losses of calves when weaned from milk.

	Second week before weaning.		First week before weaning.		First week after weaning.		Second week after weaning.		Third week after weaning.		Fourth week after weaning.	
	Total in lbs.	Daily per head.	Total in lbs.	Daily per head.	Total in lbs.	Daily per head.	Total in lbs.	Daily per head.	Total in lbs.	Daily per head.	Total in lbs.	Daily per calf.
		lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*
Skim-milk, ten calves	165	2 35	126	1.65	220	3.14	85	1.21	110	1.57	170	2.42
Whole milk, ten calves	193	2.75	219	3.27	77	1.10	310	4.43	155	2.21	125	1.78
With dams, eighteen calves	....	....	....	....	–73	– 58	75	.59	220	1.75	150	1.19

From this table it will be seen that the calves nursed by the cows lost 73 pounds the first week after weaning, while the skim-milk calves gained 220 pounds and the whole-milk calves 77 pounds. It took several weeks for the calves nursed by their dams to recover from the effects of weaning.

The dams nursing the calves were valued at $40 per head; when weaned the calves brought from $18 to $20. The labor connected

with keeping the cows probably did not exceed from $1 to $2 per animal. The expense of keeping, including feed, pasture, etc., was valued by the owner at $12 per animal. When it is possible to raise a $20 calf from a $40 cow for from $12 to $14, a person ought to realize a handsome interest on the money invested. It should be said, however, that the owner of the cows, in making his estimate, paid only $2.50 per head for pasture for the entire season. It requires at least from two to three acres of pasture per cow. As land becomes more valuable the cost of keeping the cow must increase. This comparison does not refer to pure-bred animals that are kept for breeding purposes, where a calf will bring $100 and upwards. In that case there is no question about its profitableness, no matter by what method it is fed.

The economy of feeding grain feed in place of butter-fat in the above experiments is shown as follow:

Skim-milk calves consumed 122 pounds grain per 100 pounds gain. Whole-milk calves consumed 58 pounds grain and 31.8 pounds of butter-fat per 100 pounds gain. The 58 pounds of grain plus 31.8 pounds of butter-fat is equivalent to 122 pounds of grain. Subtracting the 58 pounds of grain from 122 pounds, we have 64 pounds of grain, equivalent to 31.8 pounds of butter-fat. At this rate, 100 pounds of grain is equivalent to 48 pounds of butter-fat. Figuring butter-fat at 15 cents per pound, the 100 pounds of grain will save $7.20. At 20 cents per pound, it will save $9.60 worth of butter-fat.

AN EXPERIMENT WITH RENNET. This experiment was planned to see if the addition of rennet to skim-milk would make any difference in the ability of the calf to utilize it, Rennet extract, such as is used in cheese-making, was added to the skim-milk at the rate of one cubic centimeter per calf per feed. The rennet was added to the milk just prior to feeding, but sometimes before the milk was entirely drunk the rennet would coagulate the milk, and the calf would finish his meal by eating the clabbered milk. In this test both hand-separator and sterilized skim-milk were used, in order to see the action of the rennet on each. With the sterilized skim-milk the rennet had no appreciable effect, while with the hand-separator milk it produced a thick clabber in a few minutes. The results are shown in table XI.

This table shows that there is practically no advantage in adding rennet to the milk.

Summarizing the results obtained in feeding milk, it will be seen that the best method is to feed sweet milk, either from the hand separator or sterilized from the creamery; that there is considerably more profit realized per animal where skim-milk is fed in place of whole milk, or in place of allowing the calves to run with the cows,

TABLE XI.—Results in adding rennet to skim-milk.

	Number of calves.	Days fed.	Skim-milk fed (pounds).	Grain fed (pounds).			Roughness fed (pounds).				
				Shelled corn.	Ground Kafir-corn.	Total.	Prairie hay.	Alfalfa hay.	Oat hay.	Mixed hay.	Total.
Lot 1, with rennet...	10	140	16,120.5	1,149	1,149	2,298	1,990	5,870	1,131	346	9,337
Lot 2, without rennet.....	10	140	16,496.0	1,149	1,167	2,316	1,816	4,186	780	862	7,644

	Average gains, in pounds.		Feed consumed per 100 pounds gain (pounds).		
	Per head.	Daily per head.	Milk.	Grain.	Roughness.
Lot 1, with rennet.....	193.0	1.37	835.25	119.6	483.78
Lot 2, without rennet..	188.5	1.34	875.11	122.86	405.51

providing, however, that the latter produce a large enough quantity to pay a man to milk them.

In the vicinity of creameries, buttermilk can sometimes be had at very reasonable figures, and in order to test both the value of buttermilk and also the feasibility of feeding sour milk to young calves, an experiment was inaugurated, January 21,1903, in which one lot of calves was fed on buttermilk in comparison with another lot fed skim-milk, the grain and roughness being the same in both cases. These results are summarized in table XII.

TABLE XII.—Buttermilk and skim-milk compared as feed for calves.

	Number of calves.	Days fed.	Skim-milk.	Grain fed (pounds).			Roughness fed (lbs.)		
				Shelled corn.	Ground Kafir-corn.	Total.	Prairie hay.	Alfalfa hay.	Total.
Check lot.....	10	126	19,841.9	2,101.5	2,101.5	4,203	2,392	5,915	8,307
Buttermilk lot.....	10	126	Buttermilk. 19,730	2,092.5	2,092.5	4,185	1,790	4,305	6,095

	Average gains, in pounds.		Feed consumed per 100 pounds gain.		
	Per head.	Daily per head.	Skim-milk.	Grain.	Roughness.
Check lot.....	251.1	2.02	777.79	164.75	325.63
Buttermilk lot.....	225.5	1.79	Buttermilk. 874.94	185.58	270.51

From the figures presented, the buttermilk lot did not make quite as rapid gains as the skim-milk lot. Nevertheless the experiment shows beyond a doubt that calves can be successfully raised on buttermilk. In this experiment the buttermilk calves had less trouble from scours than the skim-milk calves.

FEEDING WHEY.

While there are comparatively few cheese factories in the state, they are numerous enough to make the question of how to utilize whey an important one. Whey, unlike skim-milk, has the casein as well as the butter-fat removed. Our experience consists of two trials; the first one began January 31,1900, and extended to March 21 of the same year.

On account of the low nutrient quality of whey, an effort was made to increase the nutrients of the calf ration by feeding plenty of alfalfa, Kafir-corn meal, oats, and soy beans. This ration figured out very nicely as far as composition was concerned, but when we came to feed it we found that we had two feeds, namely, alfalfa and soy beans, that were very loosening, and the combination of the two with whey was too much for the calves; we found later that it is impossible to feed soy beans in large quantities, as they invariably cause scours. After the above experience the grain ration was changed to Kafir-corn alone. The results of this experiment are recorded in table XIII.

TABLE XIII.—Results in feeding whey to calves.

FIRST TRIAL.	Number of calves.....	Days fed.....	Grain fed (pounds.)							Roughness fed (lbs.)			
			Whole milk. (lbs.)	Skim-milk. (lbs.)	Whey. (lbs.)	Kafir-corn meal.....	Oats.....	Soy beans...	Total,.....	Alfalfa hay..	Prairie hay..	Mixed hay...	Total.....
Whey lot...	7	50	104.5	59.5	3362	751.8	15.4	15.4	782 6	600.6	47.6	....	648.2
Skim-milk lot.....	7	50	122.5	3761.5	....	627.9	....	....	627.9	518.7	32.9	79.8	631.4

	Average gains.		Feed consumed per 100 pounds gain.				
	Per head.	Daily per head.	Whole milk.	Skim-milk.	Whey.	Grain.	Rough-ness.
Whey lot.....	53.20	1.06	28.09	15.97	984.4	210.15	174.24
Skim-milk lot.....	66.58	1.33	26.28	807.18	.....	134.74	135.49

It will be noticed that the whey calves gained very poorly, and results obtained from feed consumed was very unsatisfactory.

In the second trial our experience was of much value to us. In place of alfalfa hay we used prairie hay, and for a grain ration we

used a mixture of Kafir-corn meal and sifted oats. The calves were from three to five weeks old when placed on the experiment. It took two weeks more to change the skim-milk to whey, as the substitution had to be made very gradually, The calves were started on a full feed of whey February 5,1901; they were continued on whey until March 20, a period of six weeks. The whey was fed at a temperature of 90 to 100 degrees; the amount fed to each calf was from ten to fourteen pounds per day, divided into two feeds. The calves seemed to relish their grain ration, and it seemed to have the desired effect on the bowels, and, as a result, very little trouble was experienced from scouring. As soon as one was noticed getting off its feed its supply was cut down and its tendency to scour checked. Prairie hay was given to them all the time.

At the end of six weeks the calves fed whey were strong and healthy, had splendid appetites, and looked as well as the average skim-milk calf that is raised on the farm. Although not fat, they were in a thrifty, healthy condition.

Our experience given in connection with the experiences of men in cheese districts indicates that if we will take the pains of compounding other foods to be used in connection with whey, and carefully watch the calves, it is possible to raise very fair animals with whey as a substitute for milk.

FEEDING HAY TEA.

To further solve some of the calf problems in the cheese districts and in localities where milk is used for human consumption, an experiment was inaugurated to feed calves hay tea. Two kinds of hay were used. First, mixed hay, which consisted largely of orchard-grass, English blue-grass, and a little Red clover; second, alfalfa hay.

In test 1, the grain ration was first figured out for ground Kafir-oorn one part, oil-meal one part, middlings one part, and soy-bean meal one part, The above ration was soon found to be too loosening, and the grain was changed to equal parts of ground Kafir-corn and middlings. Three-fourths of a pound of oil-meal was made into a jelly and fed to the hay-tea lot daily. As the calves were still snbject to scours, the middlings were scalded and fed in with the hay tea. It was found that a few of the calves would not drink the tea unless there was some skim-milk added to it. (See figs. 5 and 6.)

In making the tea a large skim-milk vat was used, and under this was constructed a fireplace. The hay was placed in the bottom of this tank and sufficient water added to completely cover it, and. after being allowed to soak for a short time the fire was started, the tank covered, and the hay kept in boiling water from one to two hours,

after which the hay was placed on a draining board and the tea allowed to drain back into the tank. After all the hay was taken out of the tank the tea was concentrated by further boiling. We found that it required twelve and one-half pounds of hay to produce 100 pounds of tea. The cost of producing 100 pounds of tea was as follows:

Coal	$0.038
Hay	.025
Labor	.045
Total	$0.108

In this cost both the coal and the hay were figured at four dollars per ton. The coal consumed per 100 pounds of tea was 19.1 pounds. We found the tea could be kept about forty-eight hours, and in cool weather this time could be increased twelve or twenty-four hours. The result of the gains and the feed consumed are shown in table XIV.

TABLE XIV.—Results in feeding hay tea.

	Number of calves fed	Days fed	Grain fed.								Roughness fed.		
			Mixed-hay tea	Alfalfa tea.	Skim-milk.	Kafir-corn meal.	Middlings.	Oil-meal.	Soy beans.	Total.	Alfalfa hay.	Mixed hay.	Total.
Mixed-hay-tea lot	10	133	19,705	.....	.....	947	2,015	408.0	36	3,406.0	...	1,780	1,780
Alfalfa-hay-tea lot	10	128	.....	7,668.5	759.5	315.5	772	249.6	...	1,337.1	634	.....	634

	Average gains.		Feed consumed per 100 pounds gain.				
	Per head.	Daily per head.	Mixed-hay tea.	Alfalfa tea.	Skim-milk.	Grain.	Roughness.
Mixed-hay-tea lot	114.7	0.862	1,717.95	.....	.....	296.94	155.18
Alfalfa-hay-tea lot	46.7	0.364	.....	1,642.07	162.63	286.31	135.76

It will be noticed that these calves gained very poorly, and those on alfalfa-hay tea made poorer gains than those on mixed hay. The alfalfa seemed to be so loosening that it was almost impossible to keep the calves from scouring. The cost per 100 pounds of gain in the hay-tea lots is as follows:

Mixed-hay-tea lot:

Cost of hay tea at $0.108 per cwt.	$1.85
Cost of grain at 50 cents per cwt.	1.48
Cost of roughness at $4 per ton.	.30
Total cost per 100 pounds gain.	$3.63

Alfalfa-hay-tea lot:

Cost of alfalfa-hay tea at $0.108 per cwt.	$1 77
Cost of grain at 50 cents per cwt.	1 43
Cost of roughness at $4 per ton	27
Cost of skim-milk at 15 cents per cwt.	24
Total cost per 100 pounds gain	$3 71

FEEDING GRAIN.

WHEN TO FEED. Calves will begin to eat grain when from seven to ten days old. The best way to start them is to put a little grain in their mouths immediately after feeding their milk, and in this may their attention is called to the grain instead of sucking each others ears and mouths. This taste will soon lead them to the feed-boxes, where they will eat greedily.

MIXING GRAIN WITH MILK. It is not advisable to mix corn, Kafir-corn or any other starchy feed with milk. While the starch in grain takes the place of fat in milk, its form must be changed to sugar before it is digestible. This change is effected by the alkaline fluids and chiefly by the saliva of the mouth. If the grain is gulped down with the milk, there is no time for the saliva to act, and as the gastric juice of the stomach is acid instead of alkaline, the starch is not acted upon until it reaches the intestines. The intestines of the calf are comparatively short, and complete digestion cannot take place. In this respect the calf differs from the hog, which has a comparatively small stomach and long intestines. The hog may gobble down his starchy food without waiting for it to be acted upon by the saliva in the mouth, and it will be digested in the intestines.

IN WHAT FORM SHOULD CORN BE FED TO CALVES? This experiment consists of a comparison of shelled corn with corn chop as grain for young calves. The experiment began by taking twenty head of

TABLE XV.—Shelled corn and corn chop compared.

	Number of calves.	Days fed.	Grain fed (lbs.)			Roughness fed (lbs.)			
			Skim-milk.	Corn chop.	Shelled corn.	Alfalfa hay.	Mixed hay.	Prairie hay.	Total.
Corn-chop lot.	10	133	18,652.5	2,287.7	.....	970	2,068	4,040	7,078
Shelled-corn lot.	10	133	17,950.0	.....	2.611.7	970	2,078	4,040	7,088

	Average gains (lbs.)		Feed consumed per 100 lbs. gain (lbs.)		
	Per head.	Daily per head.	Skim-milk.	Grain.	Roughness.
Corn-chop lot.	212.3	1.59	878.59	107.71	333.39
Shelled corn lot.	232 2	1.74	773.04	112.47	305.25

grade Short-horn and Hereford calves, and dividing them into two lots as nearly equal as possible. Both lots were treated alike, except in the form of the grain fed. The results are brought out in table XV.

From that table we see that the calves fed shelled corn made the best gains. We found that the calves would begin eating shelled corn when from two to three weeks old, they relished it, and were less subject to scours than those fed corn chop. This experiment shows that it is possible to raise good, thrifty calves that will gain one and three-fourths pounds per day on feeds produced entirely on the farm and in a form that needs no extra preparation, outside of harvesting, except shelling.

IN WHAT FORM SHOULD KAFIR-CORN BE FED TO CALVES? After the excellent results secured with shelled corn, it was thought advisable to see what results would be obtained by feeding whole Kafir-corn. In a similar manner, twenty head of young grade calves were divided into two lots of ten each, with results as given in table XVI; the feed differing only in the form in which the Kafir-corn was fed.

TABLE XVI.—Whole and ground Kafir-corn compared.

	Number of calves.....	Days fed....	Skim-milk...	Grain fed.		Roughness fed.				Average gains.	
				Whole Kafir-corn.	Ground Kafir-corn.	Alfalfa hay.	Prairie hay.	Or-chard-grass.	Total.	Per head.	Daily per head.
Whole Kafir-corn lot..	10	112	14,620	1,641	.....	5,982	2,382	125	8,489	162.1	1.44
Ground Kafir-corn lot..	10	112	14,748	.....	1,394.5	6.222	2.381	125	8.728	177.7	1.58

	Feed consumed per 100 lbs. gain.		
	Skim-milk.	Grain.	Rough-ness.
Whole Kafir-corn lot.....	901.91	101.23	523.68
Ground Kafir-corn lot.....	829.93	72.78	491.16

The table shows that the best results were obtained from the use of the ground feed. Kafir-corn seems to be too hard for the young calves to masticate and digest, and it was noticed that considerable grain was passed through whole. However, the experiment demonstrates that very fair calves can be raised on skim-milk and whole Kafir-corn with such roughness as may be available on the farm.

Taking the two experiments together, we find that shelled corn and ground Kafir-corn are the forms in which these grains should be given to calves. In nearly all feeding experiments, it is found that a mixture of corn and ground Kafir-corn gives better results than either

one alone. The practice of feeding the two has been in vogue at this Station and has proven very satisfactory, as indicated in table where the results with the different skim-milk lots are compared.

LIMITING THE GRAIN RATION. In the various experiments with skim-milk it was noticed that the calves ate considerable grain, and the question arose as to whether they did not eat more than was really utilized at a profit. In order to test this matter, two lots of calves, divided in the same manner as in the previous experiments, were placed in the feed-lots, one lot getting all the grain that it would eat up clean, and the other lot receiving only three-fourths as much as the first lot. The results of this test are given in table XVII.

TABLE XVII.—Effect of limiting the grain ration.

	Number of calves.	Days fed.	Skim-milk	Grain fed.			Roughness fed.					
				Shelled corn.	Ground Kafir-corn.	Total.	Prairie hay.	Alfalfa hay.	Oat hay.	Mixed hay.	Tame hay.	Total.
Full-grain-ration lot.	10	140	16,496	1,149.0	1,167.0	2,316.0	1,816	4,186	780.0	862	.....	7,644.0
Three-quarters grain ration lot.	10	140	16,199	861.8	861.8	1,723 6	2,176	6,753	745.2	416	161.5	10.251.7

	Average gains.		Feed consumed per 100 pounds gain.		
	Per head.	Daily per head.	Milk.	Grain.	Roughness.
Full-grain-ration lot.....	188.5	1.34	875.11	122.86	405.51
Three quarters grain ration lot....	160.9	1.14	1,006.77	107.12	637.14

It will be noticed that the calves getting the full grain ration made the best gains, but the amount of grain consumed per 100 pounds of gain is greater than the lot getting only three-fourths of the full grain ration. Where grain is high and there is no particular object in forcing the calves to the greatest possible limit, the grain ration may be reduced with profit,

VARIETY IN THE GRAIN RATION. Since a mixture of any two grains give better results than any one alone, the question arises as to whether a still greater variety would not be a benefit. In the same manner of the above experiments, two lots of calves of ten each were put in the feed-lot January 21,1903. The grain ration of one consisted of shelled corn and ground Kafir-corn, equal parts; the other lot received a variety of grains, mixed in the following proportions: Shelled corn, 10 pounds; ground Kafir-corn, 10 pounds; whole oats, 6 pounds; bran,

6 pounds; oil-meal, 2 pounds; dried blood, ½ pound. This experiment was first started in November, 1902. Three of the calves became sick and died and it became necessary to fill their places with other calves. This caused a redivision of the lots and starting anew with the experiment. For this reason, these calves were older when the experiment began than those in the previous experiment. The results are summarized in table XVIII.

TABLE XVIII.—Effect of variety in the calf ration.

	Number of calves.	Days fed	Skim-milk	Grain fed.						
				Shelled corn.	Ground Kafir-corn.	Bran	Oats	Oil-meal	Dried blood.	Total.
Mixed-grain lot	10	126	19,382	1,235.6	1,236.6	735.4	735.4	244.8	60.9	4,248.7
Check lot	10	126	19,841.9	2,101.5	2,101.5					4,203.0

	Roughness fed.			Average gains.		Feed consumed per 100 lbs. gain.		
	Prairie hay	Alfalfa hay	Total.	Per head.	Daily per head	Skim-milk	Grain.	Roughness
Mixed-grain lot	361	6,980	7,341	220.2	1.74	880.19	192.94	333.37
Check lot	2,392	5,915	8,307	255.1	2.02	777.79	164.75	325.63

As far as this experiment goes, there seems to be no gain in furnishing calves a large variety in the grain ration,

ADDING FLAXSEED MEAL OR BLACHFORD'S MEAL TO THE CALF RATION. Several authorities on calf rearing advised the addition of flaxseed meal to the ration, in order that the fat in this meal may be utilized to take the place of the fat extracted from the milk in the process of separation. Blachford's calf meal has also been recommended for this purpose. The flaxseed meal was made into a jelly, and the quantity fed was increased gradually from a tablespoonful to one-half pound daily per head. Blachford's meal was made into a gruel and fed in about twice the quantities that flaxseed meal was. All the calves mere given what Kafir-corn meal, hay and green alfalfa they would eat. The calves receiving the flaxseed meal did not do as well as those without it. Those getting Blachford's meal gained a little better than the others, but as the meal costs in the neighborhood of $70 per ton and flaxseed meal in the neighborhood of $125 per ton, it certainly will not pay the farmer to use these high-priced substitutes

for butter-fat unless he can make better gains than were made in our experiment.

EFFECT OF FEEDING BLACHFORD'S SUGAR AND FLAXSEED AND DRIED BLOOD AS A PART OF THE GRAIN RATION. Thirty calves, divided in three lots of ten each, were used in this experiment. The results are recorded in table XIX.

TABLE XIX.—Results with Blachford's sugar and flaxseed and dried blood.

	Number of calves	Days fed	Grain fed. Skim-milk	Blachford's sugar and flaxseed	Shelled corn	Ground Kafir-corn	Dried blood	Total
Dried-blood lot	10	105	13,215.5	.....	1,030	1,030	68.5	2,128.5
Blachford's sugar and flaxseed lot	10	105	13,557.5	529.2	1,088	1,088	....	2,705.2
Check lot	10	105	13,542.5	.....	1,048	1,048	....	2 096 0

	Roughness fed. Prairie hay	Alfalfa hay	Total	Average gains. Per head	Daily per head	Feed consumed per 100 pounds gain. Milk	Grain	Roughness
Dried-blood lot	4,090	3,100	7,190	177.5	1.69	750.16	119.91	405.06
Blachford's sugar and flaxseed lot	3,910	3,100	7,010	186.7	1.77	726.16	144.89	375.46
Check lot	3,855	3,300	7,155	186.3	1.77	726.91	112.50	384.05

Although dried blood serves an excellent purpose as a tonic, it did not prove, in this experiment at least, of any particular value as a feed. The calves did not like the taste of dried blood when used in large quantities, and when too much was mixed with the grain they refused to eat the mixture.

The calves did well on Blachford's sugar and flaxseed, but no better than the check lot receiving shelled corn and ground Kafir-corn. Both lots gained the same, but the check lot made their gains on less feed. This experiment, like the preceding one, emphasizes the fact that it is not necessary to go off the farm to find suitable feed for calves. There is no doubt but that excellent gains can be made from the use of feeds grown on the farm. It should be the aim of every farmer to supply his needs and buy just as little high-priced concentrates as possible.

VARYING THE RATION FOR DAIRY CALVES. When calves are fed for future usefulness in the dairy, care should be taken not to get

them too fat. In the early part of the feeding period, when the calves are receiving a large amount of skim-milk and comparatively little grain, there is not much danger of getting them too fat, but as the grain ration increases it may be necessary to feed more nitrogenous grain. This can be done by changing a part of the corn or Kafir-corn for oats, bran or oil-meal whenever the calves appear too fleshy.

FEEDING ROUGHAGE.

Calves will begin to eat hay about the same time they will begin to eat grain, namely, when from ten days to two weeks old. They will not eat very much at first, but what they do have should be bright and clean. Tame hay from mixed grasses is probably the best for young calves. Bright prairie-grass is a close second. Clover and alfalfa can be gradually added to the roughage ration after the calves are several weeks old. We have tried alfalfa alone for young calves and find that it is too loosening. It proves a splendid feed, however, as the calves grow older, and should be introduced as soon as the calves can properly handle it. Avoid feeding in large quantities at any one time, but give them what they will eat up clean at each feed.

Difficulty is sometimes experienced in putting calves on pasture. On May 8, 1901, this Station put twenty head of calves on pasture, making the change gradually. We allowed them on pasture only a short time the first day, and increasing the period each time until they become accustomed to it. For the two weeks after we started to turn on pasture the calves gained only 0.89 of a pound daily per head, although weather conditions were ideal. For several weeks before turning on pasture the calves had gained 1.2 pounds per day, under adverse weather conditions. As previously stated, sudden changes of food are usually injurious, and changing to pasture is at best a sudden one. We partially overcame this difficulty with another lot by adding a little green feed to their hay before turning out the first day. This was continued, increasing a forkful each day until they were getting about all they would eat; after that we turned on pasture without any apparent trouble.

WATER AND SALT.

Calves enjoy clean, fresh water. A test was made by weighing the water given to thirteen calves that ranged from two to three months of age. It was found that 868 pounds of water were consumed in seven days, or nearly ten pounds per day per head. It was also noticed that the calves drank several times a day, sipping a little at a time; even after their ration of milk they would take a swallow of water. An automatic waterer situated a little above the surface of the ground is the best arrangement for supplying this want.

Calves seem to demand salt as well as older stock, and this should be kept before them at all times.

CALF TIES.

Where there are only a few calves to be fed, fairly good ties can be had by the use of short ropes with snaps, to be fastened to ropes around the calves' necks, supplied with rings. When this method is employed the calves should be hitched far enough apart to prevent their reaching each other after drinking their milk.

By far the best method of fastening calves is by means of stanchions. Here the calf finds his place and waits his turn. The feeder can set a bucket of milk down to the calf and then feed others, without fear of the calf tipping the bucket over. Where the stanchions are properly constructed, the calves cannot reach each other, and they can be left in the stanchions until their mouths are dry.

We find that calves will commence eating grain sooner when fastened in stanchions than when tied with ropes. The College has recently erected some new calf-sheds, in which are placed what we consider up-to-date calf stanchions. (See figs. 7 and 8.)

Our shed is sixteen feet wide, and closed at both ends and on the north side. The south side has movable panels, which enable us to close the shed in winter and to have it open in summer. There is an alleyway five feet wide in front of the stanchions, to enable the feeder to go in with a cart and have plenty of room to move around. The lumber required for ten stanchions is as follows:

1 piece 1″x12″x12′, for bottom of feed-box.
2 pieces 1″x12″x16′, for bottom of feed-box (8 ft.), upright partitions (24).
2 pieces 1″x6″x10′, for front of feed-box.
5 pieces 1″x6″x16′, cypress or full-thickness pine, for top and bottom rails.
5 pieces 1″x4″x12′, full thickness, for fixed uprights.
2 pieces 1″x4″x16′, ¾″ thick, for swinging uprights.
10 pieces 3″x6″x1″, for tongues or locks.
3 posts 6 feet in length.
3 blocks 6″x12″ under feed-box.

The six-inch upright in the picture is replaced in the above calculation by a four-inch piece, which will answer just as well.

The stanchions are two feet wide between the partitions and three and one-half feet high. The board along the front of the feed-boxes is hinged, so it may be turned down and the boxes thoroughly cleaned out. At the end of the stanchion is a rack for hay, as shown in figure 8. With these stanchions a feeder can keep four pails going and can feed a bunch of calves in a very short time. One of the feeders at this Station timed himself with twenty calves, and found that he could weigh the milk for the calves in ten minutes, thus making one-half minute for each calf.

SCOURS OR DIARRHEA.

Undoubtedly the greatest difficulty that the calf-feeder has to contend with is scours. Here, as elsewhere, "an ounce of prevention is worth a pound of cure." The principal causes of this difficulty are overfeeding, sour milk, feeding cold milk, feeding grain with the milk, using dirty milk-pails, very cold water, too much water after periods of thirst, and irregularity in feeding. The careful feeder will watch very carefully the effect of his feed upon his calves, and as soon as there are any signs of scours the milk should be reduced one-half or more and gradually increased again as the calf is able to stand it.

The Kansas Station has been very successful in using dried blood as a tonic for weak or scouring calves. A mild case of scours can usually be cured in from one to two days by reducing the milk and adding a teaspoonful of dried blood while the calf is drinking.

In a test that was made with five calves that were scouring at the same time, two were fed dried blood after reducing the regular feed of milk; the others were fed dried blood without changing the feed of milk. In the former case the calves recovered after two feeds and the latter after three feeds.

For weakly or sickly calves, the following experiments may be of value to the reader:

In the spring of 1899, the Station had a calf that did very poorly; in seventy-nine days it gained only four pounds. After trying several other remedies, dried blood was used with success; the calf began to gain, and by the time it was a year old weighed 578 pounds.

In October, 1900, a heifer belonging to the College dropped her first calf; the calf was small and sickly, and for the first few weeks did very poorly, as will be seen by the statement that on December 1 it weighed two pounds less than it did November 1, and for a few weeks its life was in a very critical condition. As soon as it was induced to eat a little dried blood it made very fair gains,

In feeding dried blood a teaspoonful at a feed is a great plenty. This should be continued until the scours disappear, or, in the case of a weak calf, the allowance may be increased to a tablespoonful per feed. The blood should be thoroughly mixed with the milk, to prevent its settling to the bottom of the pail.

The packing companies are now making soluble blood-meal that is claimed to dissolve in milk much more readily than the regular dried blood. No dried blood should be used that has not been thoroughly sterilized; otherwise it would be comparatively easy to carry disease into the herd.

In severe cases of scours, the addition of one or two eggs with the dried blood has been found to be very effective.

Another remedy that has been found to be successful is to give from one to two ounces of castor-oil in the morning, and follow in about twelve hours with fifteen to twenty drops of laudanum and a teaspoonful of dried blood. If the case is a persistent one, one or two raw eggs may be added, as mentioned above, which mill help to keep the calf from suffering from hunger, as, under such conditions, it is useless — yes, worse than useless — to give it much milk.

DEHORNING CALVES.

It is much easier, to say nothing of being more humane, to dehorn calves when they are young, preferably when from three to four days old. Clip the hair away from the button; take a stick of caustic potash, wrapped in some material to protect the fingers, moisten one end with water, and rub gently over the button until the skin becomes slightly raw and smarts a little. In a few days a scab will form, which will soon disappear, and, if the work is properly done, will leave the calf without horns. One application is usually enough, but in case the horns start again the application can be repeated. Care should be taken that none of the caustic potash runs down over the hair, to injure the eyes and skin.

In case the horns break through the skin before the caustic is applied, it will probably be necessary to use a knife to cut off the button, after which a little caustic potash can be rubbed over the exposed surface.

There are a number of chemical preparations which give good results, but a man cannot afford to pay very much for them, as caustic potash is comparatively cheap and effective.

TABLE XX.—Weights of skim-milk calves at different ages.

Number of individuals considered.	Age in months.	Range of weights.	Average weight.	Number of individuals considered.	Age in months.	Range of weights.	Average weight.
23	Birth.	59–108	77.0	26	6½ mo.	313–486	369.8
32	½ mo.	66–112	87.7	38	7 "	288–461	402.5
45	1 "	70–154	111.4	25	7½ "	353–541	486
35	1½ "	77–149	117.1	28	8 "	332–507	455.1
56	2 "	88–199	144.4	20	8½ "	394–600	469
36	2½ "	117–220	152.6	21	9 "	370–575	514.8
60	3 "	111–248	181.3	18	9½ "	430–653	515.4
36	3½ "	135–275	189.0	20	10 "	427–645	577.5
60	4 "	148–290	229.1	17	10½ "	420–747	577.6
35	4½ "	189–346	247.3	20	11 "	444–730	625.7
54	5 "	183–362	286.9	16	11½ "	452–773	644.7
28	5½ "	263–412	309.3	19	12 "	476–770	669.4
43	6 "	228–425	349.4				

WEIGHT OF A SKIM-MILK CALF.

The question is often asked as to how large a skim-milk calf should be and what weight it should attain at different ages. In order to give a satisfactory answer to this question, we have averaged up the weights of a large number of skim-milk calves that we have raised at this Station. Table XX gives both the range of variation and the average weights that have been obtained at the ages mentioned.

COST OF RAISING A SKIM-MILK CALF. In order to determine what is the cost of raising a skim-milk calf, the different experiments have been combined in the following table; charging fifteen cents per 100 for skim-milk, fifty cents per 100 for grain, $4 per ton for roughness and ten cents per hour for labor:

TABLE XXI.—Cost of raising skim-milk calves.

Experiment No.	Number of days fed.	Number of calves.	Milk fed.	Grain fed.	Roughness fed.	Labor.	Total.	Cost per calf.
1.....	150	10	$37 10	$14 03	$1 28	$25 50	$77 91	$7 79
2.....	133	10	27 98	11 43	14 16	22 61	76 18	7 62
3.....	133	10	26 92	13 06	14 18	22 61	76 77	7 68
4.....	112	10	22 12	6 97	17 46	19 04	65 50	6 55
5.....	112	10	21 93	8 20	16 98	19 04	66 15	6 61
6.....	105	10	20 34	13 53	14 02	17 85	65 74	6 57
7.....	105	10	19 82	10 64	14 38	17 85	62 69	6 27
8.....	105	10	20 31	10 48	14 31	17 85	62 95	6 29
9.....	140	10	24 26	8 66	18 67	23 80	75 33	7 53
10.....	140	10	24 30	8 62	20 50	23 80	77 22	7 72
11.....	140	10	24 18	11 49	18 67	23 80	78 14	7 81
12.....	126	10	28 99	27 70	14 50	21 42	92 61	9 26
13.....	126	10	29 67	21 00	16 50	21 42	88 59	8 86
Average,	125.15	10	$25 22	$12 75	$15 05	$21 28	$74 29	$7 43

PROFITS REALIZED BY MILKING THE CORNS. From table XX, we see that at six months of age the average calf weighs 349 pounds, From table VI we see that the average skim-milk calf consumes 858.2 pounds of skim-milk, 124.1 pounds of grain and 387.2 pounds of hay to produce 100 pounds of gain. The feed cost of this 100 pounds of gain is $2.68, the labor 91 cents, making a total of $3.59. This 858.2 pounds of skim-milk represents 953.5 pounds of whole milk, which, with an average test of 4.08 per cent., makes a butter-fat yield of 38.9 pounds. The average price of butter-fat at the College creamery during the past year was 21.08 cents per pound. This makes a total value of $8.20. Deduct from this the cost of raising a skim-milk calf, $3.59, and we have left $4.61 to pay for the expenses of milking and hauling 953 pounds of milk to the creamery. (See figs. 9 and 10.)

These figures do not tell the whole story as to the profit. Cows that are milked produce larger yields than when suckling a calf. For in-

stance, the College herd has averaged 6273.6 pounds of milk per cow during the year 1902. The amount of skim-milk consumed by the skim-milk calf represents 1978 pounds of whole milk. Subtract this from the average product of the average cow in the College herd, and we have 4295.6 pounds to be credited to raising calves on skim-milk. According to the average test of the herd, this milk would contain 175.26 pounds of butter-fat, which, at 21.08 cents per pound, would amount to $36.95. This 4295.6 pounds of extra whole milk produced by the cow that is milked would yield 3866.1 pounds of skim-milk, which, at 15 cents per 100, would be worth $5.80, or a total of $42.75 additional income per cow. Add to this the $17.01, the income from the butter-fat secured from the milk furnishing the skim-milk for the calf, and we have a total of $59.76. Deduct from this the cost of raising a calf, $7.43, and we have left $52.33 to pay for the expenses of milking and the hauling of 6273.6 pounds of milk to the creamery.

According to statements received from successful Kansas dairymen, it takes 13 minutes to milk a cow. Assuming that an average cow will milk 300 days, we have a total of 65 hours to be charged to each cow; at 12½ cents per hour, this costs $8.12. It will probably cost 12½ cents per 100 pounds to haul the milk, making an expense of $7.84 per cow, making the total expense for milking and hauling $15.96, Subtract this from $52.33, and we have left $36.37 per head to pay interest on the money invested in a common cow, besides paying for the labor of the men and boys on the farm. (See figs, 11 and 12.)

The figures just given represent averages. No enterprising dairyman will be satisfied with averages. We found that twenty-five per cent. of the common cows purchased by the Agricultural College were unprofitable and such as every up-to-date dairyman would remove from his herd as soon as discovered. Making the above calculations on a basis of the profitable cows would show still greater profits.

WHEN WILL IT PAY TO MILK A COW AND RAISE THE CALF ON SKIM-MILK? The experience in raising calves outlined above indicates clearly that unless the cow gives considerably more milk than is needed for the calf it will not pay to milk her. It costs about $8 to pay for milking and about $7.50 to raise the calf on skim-milk. To be a profitable milker a cow must produce at least $15.50 worth of butter-fat, leaving the skim-milk to pay for hauling, With a four-percent test and 15-cent butterfat, this would mean at least 2583 pounds of milk per annum; with 18 cents for butter-fat, 2152 pounds of milk per annum; with 20 cents for butter-fat, 1937 pounds of milk per annum. If the calf was raised on whole milk the amount required to be produced would be entirely different. Nobody can afford to feed whole milk by hand to a calf.

These figures do not mean that a cow giving the above amount of milk is really profitable, for usually a dairy cow will consume more grain than one nursing a calf, but it indicates what a man must expect to get from his animals before he can bear the expense of milking and raising the calf on skim-milk.

RELIEVING CALVES FROM FLIES. During the hot summer months flies are a constant torment to young calves. The entomological department of the Kansas State Agricultural College has been experimenting and compounding various substances, in order to produce an effective and economical mixture which, when applied to the surface of an animal, would ward off the flies. As a result of these experiments, it has succeeded in producing the following formula, which seems to answer the purpose reasonably well: 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. This 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 the parts of the animal 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.

TREATMENT OF DAIRY CALVES AFTER WEANING. Skim-milk can be fed profitably five or six months, and, where milk is available and is not needed for other purposes, even longer. The weaning may be done either gradually or at once. Tests made at this Station show that there is practically no difference in either case, as will be seen from table XXII.

TABLE XXII.—Comparison of gradual and sudden weaning.

	Abrupt weaning, ten calves.		Extended over three days, ten calves.		Extended over one week, ten calves.	
	Gain one week previous.	Week after weaning.	Gain week previous.	Gain week after weaning.	Gain week previous.	Gain week after weaning.
Experiment I.....	97	114	187	62	96	105
Experiment II.....	132	85	166	53	244	45

The calves weaned gradually made more fuss than those weaned abruptly. In these cases the allowance of grain was continued when the skim-milk was taken away.

If pastures with plenty of feed, shade and water are available, young dairy stock could ask for no better quarters. If pastures become dry and scanty, it would be well to give them what they will eat of alfalfa, Red clover, or oow-pea hay. These nitrogenous feeds can be supplemented by sorghum, corn-stover, Kafir-corn stover, millet, orchard-grass, or millet hay, but there should always be plenty of leguminous crops, so as to furnish plenty of protein to develop bone and muscle. Where plenty of protein is furnished in the roughness, heifers intended for the dairy need little or no grain. In fact, it is advisable to give them bulky foods, so as to develop large paunches. If the calves are weaned in winter they should be fed plenty of nitrogenous feed. At this Station we wintered a grade herd of Guernsey heifers in excellent shape on alfalfa and sorghum without any grain. (See figs. 13 and 14.)

It is desirable to develop as much hardiness in dairy cattle as possible, and for this reason it is not best to house young dairy stock or even dry cows too warmly. Under Kansas conditions, a reasonably tight shed open to the south, with the floor well bedded, furnishes ample protection.

As there is considerable loss every year over the state from black-leg, it would be well to have the older calves inoculated to prevent this disease. At present this Station is furnishing inoculating material at cost. A man is running considerable risk in allowing his heifers to go uninoculated.

The breeding of dairy stock hardly gets within the scope of this bulletin, but as there are some breeders that are in the habit of breeding too young, even while the animals may still be called calves, a word of caution may not be out of place. Under Kansas conditions, with our liberal supply of cheap and nitrogenous feeds, it should be the aim to develop good size in our dairy cows; for, other things being equal, the larger the cow the more feed she can handle and turn into milk and butter-fat. It is never desirable to breed a heifer to calve before she is two years old, and she had better be over this age rather than under. If the heifer is a spring calf, it would be better to breed her to calve the fall following her second birthday, as fall calves are usually more profitable, both from the standpoint of the cow and the calf, Much depends upon getting the dairy heifers in the habit of calving at the time of year when they will bring the most profit.

SUMMARY. The results detailed in this bulletin ought to be a conclusive argument as to the great feeding value of skim-milk; they also indicate the possibility and even the advisability of growing the feeds that are needed upon the farm, thus saving the money that

would otherwise be invested in high-priced feed stuffs. They indicate how it is possible to realize more income from the cow and consequently greater income per acre of land — an important feature as the value of land increases. The results likewise indicate the extravagance of letting a calf nurse a good cow. It will not only eat its head off by the butter-fat it consumes, but it may materially lessen the production of the cow.

Kansas is blessed with ideal feeds for dairy cows, and, as her dairymen select and milk better cows, the greater reason there will be for raising the calves on skim-milk and the greater will be the income from our Kansas farms.

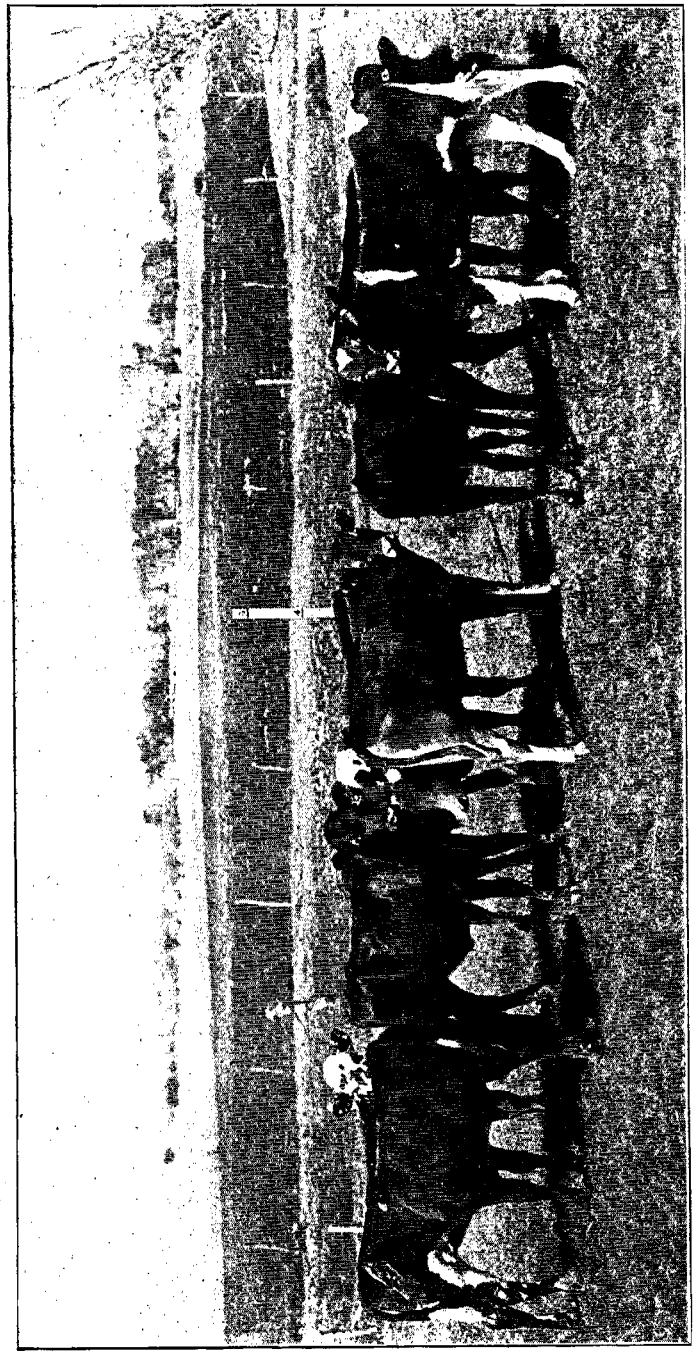

Fig. 1. A group of typical skim-milk calves. Average daily gain per head, 1.77 pounds.

Fig. 2. Calves fed skim-milk in comparison with those fed whole milk and those running with dams. Average daily gain per head, 1.51 pounds. Cost per 100 pounds of gain, including labor, $3.42.

Fig. 3. Calves fed whole milk. Average daily gain per head, 1.86 pounds. Cost per 100 pounds of gain, including labor, $6.64.

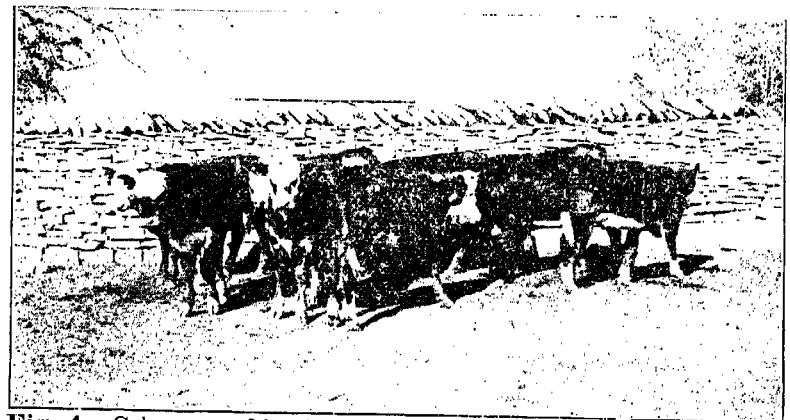

Fig. 4. Calves nursed by their dams. Average daily gain per head, 1.77 pounds. Cost per 100 pounds of gain, $4.41.

Fig. 5. Calves raised on mixed-hay tea. Average daily gain per head, 0.86 pound. Cost per 100 pounds of gain, $3.63.

Fig. 6. Calves raised on alfalfa-hay tea. Average daily gain per head, 0.36 pound. Cost per 100 pounds of gain, $3.71.

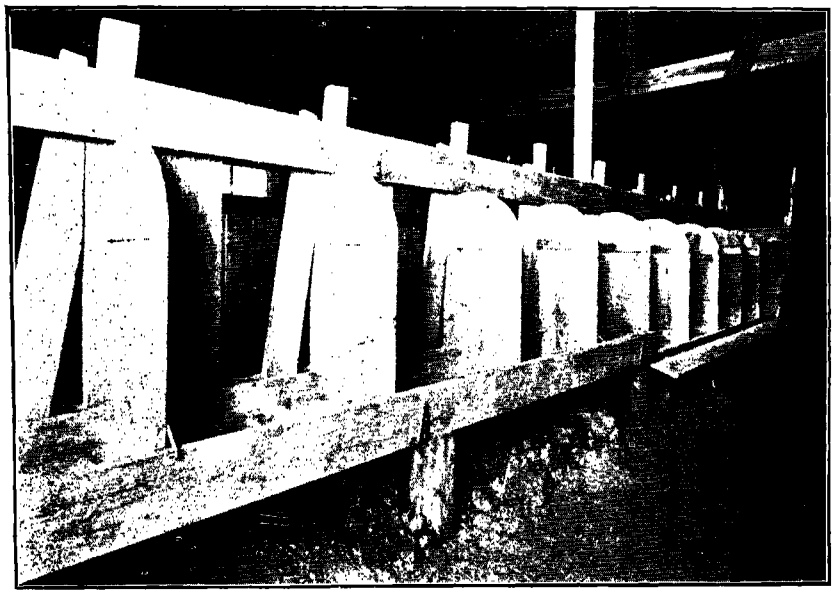

Fig. 7. Front view of calf stanchions.

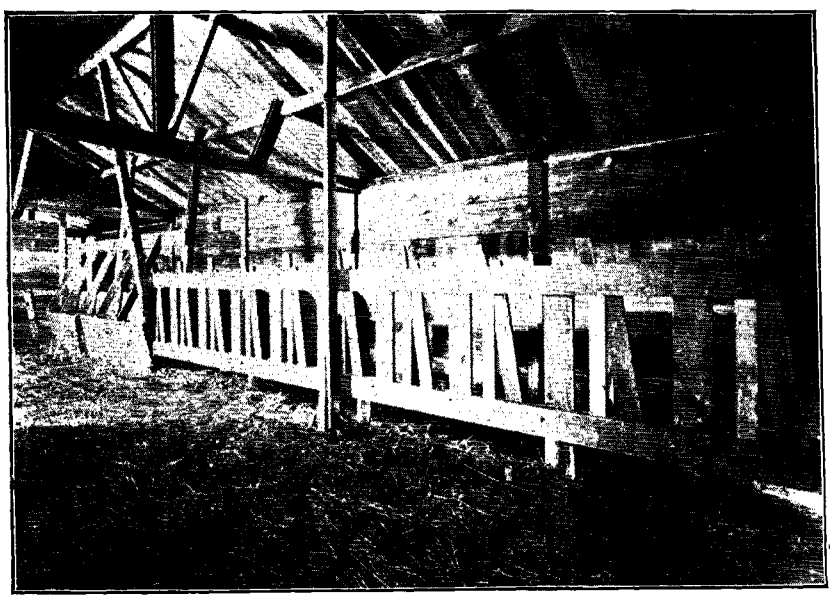

Fig. 8. Rear view of calf stanchions.

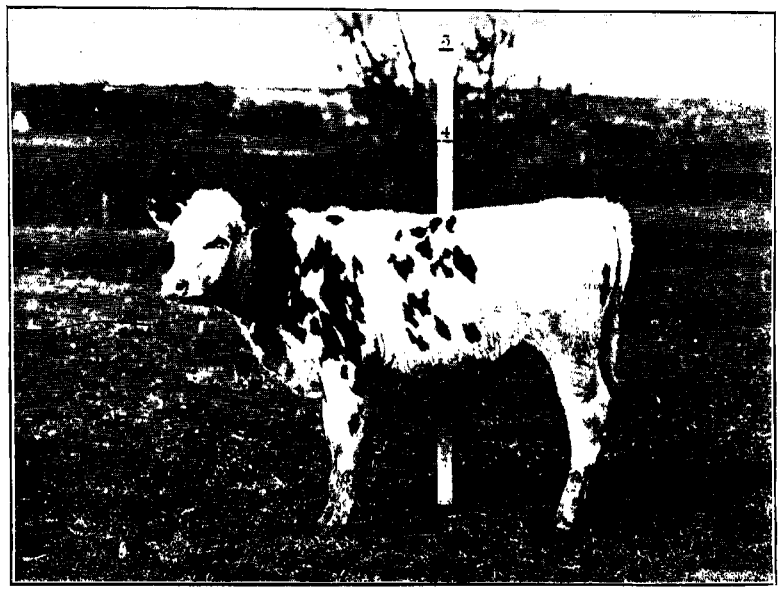

Fig. 9. A living monument to skim-milk. Average daily gain for 105 days, 2.29 pounds.

Fig. 10. A group of skim-milk money-makers. Average daily gain, 2.11 pounds.

Fig. 11. Skim-milk calves, just weaned from skim-milk and ready for the feed-lots. Average daily gain per head while on skim-milk, 1.44 pounds.

Fig. 12. The same, ready for market. Average daily gain per head since weaning, 210 days, 1.79 pounds.

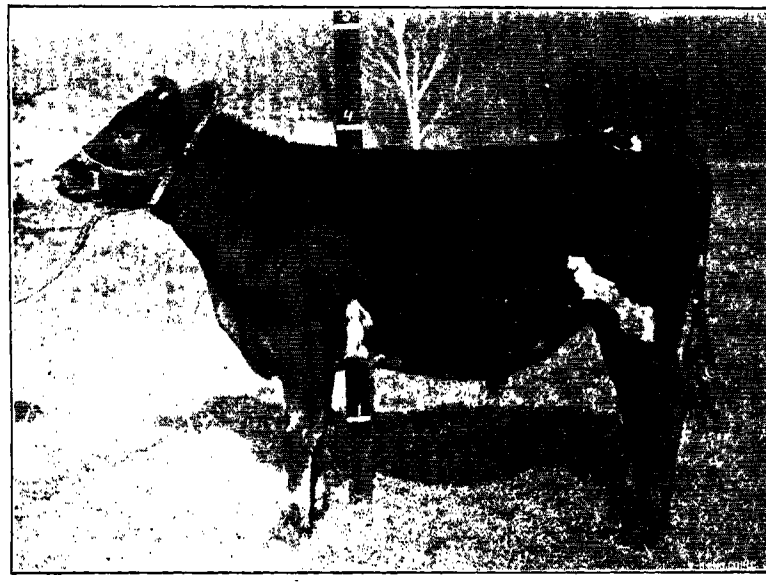

Fig. 13. A half Guernsey skim-milk steer as a yearling.

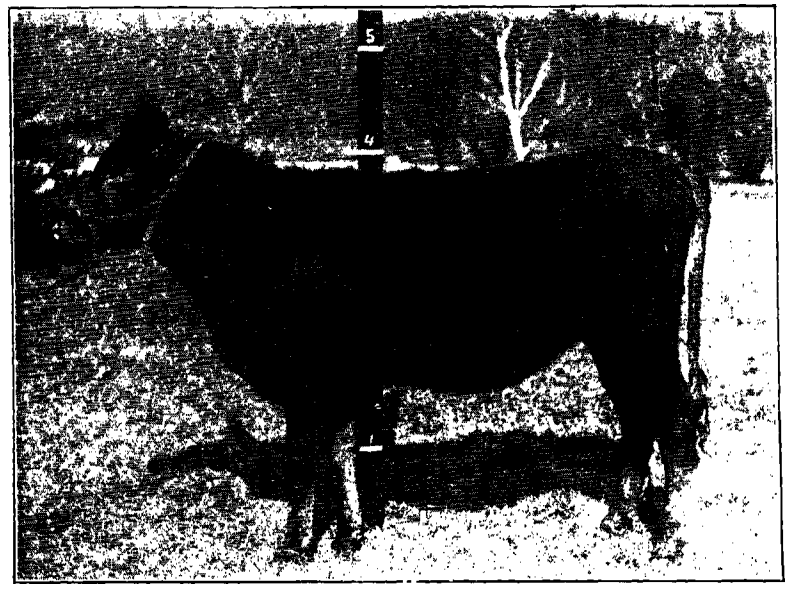

Fig. 14. A half-Guernsey skim-milk heifer as a yearling.