Feeding Dairy Cows.

JAMES WILSON.

During the winter and spring of 1895 this station continued its work with dairy cows. Eight were selected from the college herds on January first 1895, with a view to their advance in period of lactation. They had dropped calves from September 10th to December 7th. There were four Holsteins, two Short-horns and two Jerseys. The cows were not selected as the best representatives of their respective breeds on the farm, but because they were free from the extremes of fresh cows or strippers and are fairly averages of their respective breeds. I desired to ascertain the quantity and quality of milk, butter and cheese made from turnips, mangels, sugar beets and red table beets; from feeding with roots and without them; from wet and dry fodder, and the effect of feeding bran on pasture. Observations extended over 189 days, including seventy-seven days on roots, forty-six days without roots, and sixty-six days observations on pasture, with, and without bran. There was a uniform foundation ration of hay, corn-fodder, bran, gluten meal, and oil meal fed during the first two periods until the cows went to grass. This foundation ration is well known to make good dairy products.

During the seventy-seven days when roots were fed, ten preliminary and ten test days were with strap leaf purple top turnips; ten preliminary and ten test days with mangel wurzels; ten preliminary and ten test days with sugar beets, and eight preliminary and nine test days with red table beets.

The amounts eaten, the pounds of milk, butter fat and butter, the dry matter eaten, the gain or loss in weight, the dry matter eaten per pound of butter fat, and the moisture in feed and water drunk are stated in table No. 1.

Table No 1.

Date Inclusive.	Period	Fodder	Bran	Gluten meal	Oil meal	Hay	Turnip	Mangels	Sugar Beets	Red Beets	Days in Period	Pounds Milk	Pounds Butter fat	Pounds Outte	Lbs butter per cow per day	Lbs dry matter eaten	Nutritive ratios	Gain in weight	Dry matter per 1000 lbs w't per day	Lbs dry matter p'r lb butter fat
Jan. 1 to 10	Prelim.	734	800	126	73	330	1600				10	2152				1741¼	1 :4.4	60	19.67	
Jan 11 to 20	Turnip test.	690	784	157	157	440	1560				10	2343	91.19	106.38	1.32	1770¾	1 :4.1	-60	21.14	20.51
Jan. 21 to 30	Prelim,	793	801	160	160	440	260	1280			10	2398				2015	1 :4.4	-20	22.76	
Jan. 31 to Feb. 9	Mangel test	869	790	158	158	440		1600			10	2401	88.26	102.97	1.28	2021	1 :4.5	110	22.93	23.01
Feb. 10 to 19	Prelim.	742	747	147	146.5	440		640	878		10	2345				1989.4	1 :4.6	-35	21.81	
Feb. 20 to Mar. 1	Sugar beet test	711	778	152	133.5	440			1460		10	2316	85.11	99.29	1.24	2429	1 :4.7	-5	22.87	23.83
Mar. 2 to 9	Prelim.	540	613	123	107	352			384	740	8	1697				1537	1 :4.6	70	21 57	
Mar. 10 to 18	Red beet test	609	711	144	126	396				1332	9	1920	72.61	84.71	1.17	1777	1 :4.4	136	21.92	24.45

During the turnip period the roots were gradually increased over a ten day preliminary period until each cow had twenty pounds daily, ten pounds of corn fodder, two pounds of oil meal, two pounds of gluten meal, ten pounds of bran and 4.5 pounds of hay. This was the ration during the ten day test period that compares with the test periods when the other roots were fed. When a change was made from one root to another it was done gradually, over five days decreasing the one and increasing the other, so that the cows would be five days on the tested root at the beginning of the ten day test period. The cow will be beyond the influence of a root in five days as far as it affects the flavor of the milk and the butter made from it. but there are other effects of feeds that continue longer; one object in view was to determine whether injurious volatile acids from certain roots affect butter, and, if they do, what means should be used to expel them. The scoring of the butters from the several roots establish results found in previous experiments with roots at this station. An article in this bulletin on "Butter Flavor," deals incidently with this subject.

The ration in addition to the roots was continued uniformly through the four periods, changes being made in the roots only. It was purposely made as full a ration as could be fed without getting the cows off feed. Iowa is in the center of cheap fodders, and Iowa feeders can afford to feed more liberally, perhaps, than feeders farther east.

The ration was mixed twelve hours before feeding and wetted, so that it would be more easily masticated, a gentle heat was generated and palatability increased; when we wetted the ration longer than twelve hours palatability was injured. The corn fodder was cut and eaten as closely as cut fodder siloed.

Toward the close of the turnip test period the two Jersey cows refused their quota of the ration, and were fed just

what they would eat up clean, weighing being carefully done to ascertain their comparative consumption and production.

The butter fat resulting from the four tested roots varies, and a consideration of the constituents of the roots suggests the cause of it to some extent. There was 91.19 pounds from the turnips from the narrowest nutritive ratio fed during the winter, 1:4.1. It will be noticed that the cows lost sixty pounds in weight during the ten day test period, which agrees with results from turnip feeding at this station in previous experiments and indicates that corn meal might profitably be fed with turnips to keep cows in condition. It will be observed further that the 91.19 pounds of butter fat came from 2333 pounds of milk while the 2401 pounds of milk from mangels in the following test period only gave 88.26 pounds of butter fat, but the cows show a gain in weight during the mangel ten day test period of 110 pounds. It will also be seen that it took 20.51 pounds of dry matter to make a pound of butter fat when feeding turnips, which was less than any of the other roots. The turnips were the strap leaf purple top variety, grown on the college farm during the dry summer of 1894, making twenty-four tons of trimmed product to the acre.

MANGELS.

Table No. 1, shows that the maximum amount of milk was gotten from the mangels, 2,401 pounds, but the butter fat was 88.26 pounds and the cows gained 110 pounds in weight instead of losing sixty pounds as in the turnip period already stated. 23.01 pounds of dry matter, having a nutritive ratio of 1:4.5, were required to make a pound of butter fat. We have called attention to other features of mangels as cow feed in Bulletin 25.

SUGAR BEETS.

Sugar beets were fed in the next periods of ten preliminary and ten test days. The milk decreased to 2336 pounds

and the butter fat to 85.11 pounds. It will be noticed that the nutritive ratio from the same weight of a ration was 1:4.7. The sugar beet has a wider nutritive ratio than any of the other roots, its carbonaceous matter being purposely developed for sugar making. The cows lost thirty-five pounds in weight during the preliminary period and five pounds during the test period. It required 23.83 pounds of dry matter to make a pound of butter fat. We tested sugar beets for the reason that Iowa is well adapted to growing them. This station has grown twenty tons to the acre uniformly under conditions necessary to get the greatest per cent of sugar, which requires the size being limited to two pounds, root parts grown beneath the surface. We would not advise the growing of sugar beets in preference to mangels, but, in future agricultural operations in the state it may be useful to have indications of their value for dairy purposes. With our abundance of carbonaceous crops the pulp would be nearly as valuable for dairy cows after extracting the sugar. When the cow has sufficient starchy matter in her ration, protein is more effective in milk production than sugar that is similar to starch in its effects. Sugar beets are, however, very palatable, and we think grateful to the system of the dairy cow.

RED TABLE BEETS

are grown at the college for the boarding hall. A quantity remained on hand after the college year ended, and I resolved to get indications of their value for dairy purposes. There was only enough for seventeen days feeding of the eight cows. Reducing milk and fat to a ten days equivalent, I find that there was produced in the ten days 2033 pounds of milk, a considerable falling off from the sugar beet test period. There was in the nine days 72.61 pounds of butter fat or 80.67 pounds for ten days. which was also a falling off from the sugar beet period; but during the eight preliminary days the cows gained seventy pounds in weight, and during the nine

test days they gained 136 pounds. 24.45 pounds of dry matter were required to make a pound of butter fat. The column in table No. 1, showing the amount of dry matter eaten during each test period gives the same amount substantially in the sugar beet and red table beet periods, but in the case of the latter there was less butter fat and a gain in weight. I can not safely generalize on the loss of weight in the one case and gain in the other, with only one experiment.

WATER.

Water is a necessity for all animals, but especially for the dairy cow. It may be said generally that one half of the body is water. The younger the animal is the greater per cent of water its body contains, and the poorer the animal is the greater per cent of water its body contains. Very fat animals have been reported by Lawes and Gilbert to have as low as 35.2 per cent of water. The dairy cow doing good work is in thin condition; the fats made from the protein, fat and carbhydrates going toward milk production. Her product is eighty-seven per cent water in which the thirteen per cent of solid matter is contained in emulsified condition. She can not do good work and yield profitably without plenty of water. The cows in this experiment had water from three sources, the moisture in the fodders, the water used in wetting the ration twelve hours before feeding and the water drunk. From all sources each cow had daily the amounts in pounds during the several periods, shown by the following table:

Table No. 2.

HERD OF EIGHT COWS.

Period	Lbs. water drunk	Organic water	Water mixed with feed	Total water	Lbs. water per cow per day	Lbs water per lb dry matter eaten
Prelim.	6665	1952	1064	9681	121	
Turnip test	5880	1917	1150	8947	111	4.78
Prelim	5850	1900	1200	8950	111	
Mangel test	6260	2084	1200	9544	119	4.70
Prelim	5870	1763	1180	8813	110	
S. beet test	5960	1722	1000	8682	108	4.27
Prelim	5359	1375	800	7534	117	
R. table beet test	6132	1584	900	8616	119	4.85

Table No. 2 shows that each cow had from 108 to 121 pounds of water per day. The table shows that the water mixed with feed stuffs twelve hours before feeding was considerably less than the moisture in the several ingredients of the feed in air dried condition, and that water from both these sources was less than one third of what the cows drunk in addition. Care was taken to give the cows water frequently so that they would have all they wanted. Each cow had a pail of water at 5:30 a. m.; after breakfast they had all the water they would drink, before the evening meal they had all the water they would drink again. The amount of water necessary to be taken with feed is given by Wolff at four pounds for cattle, for each pound of dry matter. The requirements of animals in this regard must depend on the results expected from them. I find that during the turnip period each cow had from all sources 4.78 pounds for each pound of dry matter. In the mangel period they had 4.70 pounds. While eating sugar beets they had 4.27 pounds, and with red table beets 4.85 pounds.

In subsequent periods after the roots were all discontinued the averages were substantially the same as those already quoted from the four root periods which is 4.65 pounds for each pound of dry matter eaten.

The temperature of the barn did not fall below 36° during the winter nor rise above 60°. The temperature of the water varied from 36 to 49.

The following table shows the amount of water drunk by each of the eight cows in addition to what they got in the feed in air dried condition and what was mixed in the feed twelve hours before feeding, during sixty days or the first three twenty day periods.

Table No. 3. Pounds of Water Used.

Average weight of cows.	Cow No.	Period I	eriod I	Period III	Totals.	Lbs. water drunk per lb. dry matter eaten.	Lbs water drunk p'r1000 lbs w't a day
757	352	515	595	475	1585	2.34	69.79
1236	703	800	880	955	2635	3.44	71.03
1193	172	685	890	950	2525	3.30	70.55
1261	209	860	885	920	2665	3.52	70.44
810	354	520	550	560	1630	2 40	67.07
1215	200	730	755	730	2215	2.93	60.70
1290	166	915	920	1005	2840	3.70	73.38
1111	105	775	795	790	2360	3.08	70.80

The foregoing table shows that the amount of water drunk did not vary much per 1000 pounds of weight, while it did vary considerably in ratio to the pounds of dry matter eaten. The cows that ranked highest in economic yields drunk least water, for dry matter consumed, with some exceptions. The Jerseys drank least for amounts of dry matter eaten and cow No. 166, an aged Holstein, drunk most. The weight of the cows indicates the surface for evaporation. The reader will notice that pounds of water *drunk* in table No, 3 is independent of the moisture in the fodders, and wa ter used in mixing the feeds.

DAILY YIELD OF COWS.

The yield ot butter is found by adding one-sixth to the butter fat, that being the average over run at the Iowa College Creamery, and adopted by the Association of Agricultural Colleges and Experiment Stations, at its meeting at

Denver, as the conversion factor. During the four test periods the pounds of fat, pounds of butter and butter per cow per day were as follows:

	lbs. fat.	lbs. butter.	per cow daily.	
From Turnips,	91.19	106 38	1.32	8 cows 10 days.
" Mangels,	88 26	102.97	1.28	8 cows 10 days.
" Sugar Beets,	85.11	99.29	1.24	8 cows 10 days.
"Red table beets	72 61	84.71	1.17	8 cows 9 days.

This is an average of 1.25 pounds of butter a day for each cow for the seventy-seven days of the four root periods. The decline is gradual and may be attributed to the advance in the periods of lactation, the most marked variation being on the weight of the cows. The red table beets fed last produced more weight on the cows than any of the other roots. Table No. 10 will show the effects of stopping root feeding. The production of a pound of butter is accompanied by the consumption of about 100 pounds of water when roots were fed.

GAIN IN WEIGHT.

The gain or loss in weight of dairy cows depends upon what they are fed primarily, but to some extent on their inheritance toward milk giving or fattening. We have found that gain or loss in weight, while eating green nitrogenous soiling crops, can be controlled by the amount of grain, especially maize, fed with the ration. Where the cow got twelve pounds of corn and cob meal a day, with green feed in previous experiments, she gained weight; where she got four pounds a day she lost in weight; with nine pounds a day she neither gained nor lost weight. The ration most suitable for fattening a steer will fatten the dairy cow, provid d she possesses the characteristic of fattening as well as milk giving. Milk is a highly nitrogenous product; fat is carbonaceous. When the ration is unsuited for milk, fat is likely to be formed. Fat is deposited in the fat tissues proper, and also in the muscles between the fibers. The dairy cow

is generally a matured animal, requiring for her body only a sufficient amount of protein to maintain it and no more carbhydrates than are necessary to keep her warm outside of what she turns into the fat of her milk. If she gets more carbhydrates than she requires to make milk they are wasted or deposited as fat in her body. The following table shows the gains and losses of the cows individually.

TABLE No. 4.

INDIVIDUAL GAINS OF THE EIGHT COWS.

Cow No.	TURNIPS		MANGELS		SUGAR BEETS		RED BEETS		Total Lbs.	Aver. Daily Gains Lbs.
	I. Prelim	T st	II. Prelim	II. Test	III. Prelim	III. Test	IV. Prelim	IV. Test		
105	50	10	-40	20	30	00	18	-12	76	.98
703	00	-20	-10	50	-10	-10	14	26	40	.52
166	40	00	20	00	10	20	-48	28	70	.91
172	-40	-50	-10	10	00	00	12	58	-20	-.26
200	10	-10	10	30	-50	-10	12	28	20	.26
209	10	10	20	10	20	-10	16	14	70	.91
352	10	-10	10	10	-55	15	28	-8	00	00
354	-20	10	-20	00	20	-10	18	2	00	00
T'al	60	-60	-20	110	-35	-5	70	136	256	

There is as marked individuality among representatives of the same breed as there is contrast between the breeds. Of thefour Holsteins one lost twenty pounds, while three gained 186 pounds. Of the two Short-horns, one gained seventy pounds, and the other twenty pounds. This fact is suggestive to the farmer, who may select toward the results he desires.

The last two in the table (352 and 354) are Jerseys, of the most approved milking families. The rations caused neither gain nor loss on either. Their weight remained stationary on turnips and mangels; they lost slightly on sugar beets, and made it up on red table beets. Nos. 200 and 209 are Short-horns. They gained twenty pounds on turnips and fifty on mangels, and lost fifty on sugar beets. They gained seventy pounds on red table beets, making a gain in weight of ninety pounds in seventy-seven days.

The Short-horns fatten easily. In this case they were fed liberally and made only such gains as are desirable to prepare cows for good results in summer on pasture.

The state has more of this blood in its dairy herds than any other, and where fattening rations are fed, disappointment too often follows.

The other four cows are Holsteins. They lost ten pounds on turnips and gained forty on mangels. They gained forty pounds on sugar beets, being the only breed that gained on this root; and they gained ninety-six pounds on red table beets. They gained 166 pounds during the seventy-seven days, which is 41.5 pounds each, to forty-five each for the Short-horns, but one of the Holsteins lost twenty pounds, making the gain of three Holsteins 186 pounds or sixty-two pounds each, which is not seriously objectionable. The following table shows the gains and losses of the breeds.

Table No. 5

GAINS BY BREEDS.

Number of cows and breed	TURNIPS.		MANGELS.		SUGAR BEETS		RED BEETS.		Total gain orloss lbs.
	I Prelim	I Test	II Prelim	II Test	III Prelim	III Test	IV Prelim	IV Test	
4 Holstein	50	-60	-40	80	30	10	-4	100	165
2Shorthorn	20	00	30	20	-20	-20	28	42	90
2 Jersey	-10	00	-10	10	-35	5	46	-6	

Some light may be shed on the disposition of feed made by breeds, by consulting Bulletin No. 20 of this station and comparing the Short-horn, page 665, Holstein, page 671 and Jersey, page 682 as beef cattle. The weight of dressed beef with tallow is given in each case as follows:

	Dressed weight.	Tallow, lbs.
Short-horn	1068	141.5
Holstein	818	148.5
Jersey	763	190

These cattle were thoroughly fattened. The tallow is caul fat, paunch fat, intestine fat and bed tallow. During

nine months feeding the Short-horn had gained 718⅓ pounds; the Holstein, 629½ pounds and the Jersey 573 pounds. The Short-horn had 13,2 per cent of loose tallow; the Holstein 18.1 per cent and the Jersey 24.9 per cent. I select the animals typical of their breeds to make the comparison. The beef breeds deposit fat in the fat tissue and among the flesh fiber. The milk breeds do this to a less extent, and if fed quite fat, deposit a larger proportion in the abdominal cavity than the beef breeds. The Holstein's disposition to lay on fat seems midway between the Short-horn and Jersey in that experiment.

In our experiment under consideration the Short-horns and Holsteins behaved similarly regarding gains in weight. Much more care must be taken in compounding rations for the easy fattening dairy cow than for the one less disposed to fatten, where gain in weight is not desirable. Iowa meats are made with grass and maize almost entirely, without any attempt to add more protein, even in winter. Justified by the low price of the grain and, not only so, but the dairy products of the state are made from the same ration in a majority of the cases. The dairy products of the state from this ration excel all others, as maize gives butter and cheese fine flavors but, cows with tendencies to fatten are spoiled for dairying by the ration.

The following tables 6, 7 and 8 show the feeding and yields of the cows by breeds, of milk and butter fat.

THE BREEDS COMPARED.

TABLE No. 6—Short-horn cows, 200 and 209,

PERIOD	Days in Period	Turnips	Mangels	Sugar Beets	Red Beets	Corn Fodder	Oil Meal	Gluten Meal	Bran	Hay	Lbs Milk Per Cow		Lbs Butter Fat Per Cow		Lbs dry Matter Eaten	Nutritive Ratio	Dry Matter per 1000 lbs Wt. p'r day	Dry Matter per lb. Butter Fat
											200	209	200	209				
Preliminary	10	400	....	....	....	183	18	31	200	90	240	303	.....	.....	435	1:4.4	17 76	.....
Turnips test	10	390	....	....	....	172	39	39	196	110	265	335	10.99	12.73	467	1:4.1	19.00	19.70
Preliminary	10	80	320	....	....	210	42	42	228	110	271	340	.....	.....	534	1:4.4	21.58	.....
Mangels test	10	....	400	....	....	213	42	42	231	110	270	323	10.67	11.63	538	1:4.4	21.52	24.13
Preliminary	10	....	160	240	....	204	42	42	227	110	257	323	.....	.....	505	1:4.5	20.26	.....
Sugar Beets test	10	....	....	380	....	177	38	38	200	110	239	309	10 16	11.28	508	1:4.7	20 58	23.69
Preliminary	8	....	....	65	195	128	27	27	139	83	140	237	.....	.....	359	1:4.5	18.16	.....
Red Table Beets test.	9	....	....	....	360	136	36	36	189	99	180	250	7.74	9.50	454	1:4.4	20.11	26.33
Totals											1862	2420	39.56	45.14	3800	.....	.....	.....
Averages per day											24.1	31.4	1.01	1.15	49.38	1.4.4	19. 7	23.46

Table No. 7.—Jersey Cows, 352 and 354.

PERIOD	Days in Period	Turnips	Mangels	Sugar Beets	Red Beets	Fodder	Oil Meal	Gluten Meal	Bran	Hay	Lbs Milk Per Cow		Lbs Butter Fat Per Cow		Lbs dry Matter Eaten	Nutritive Ratios	Dry Matter per 1000 lbs Wt.	Dry Matter per lb. Butter Fat
											352	354	352	354				
Preliminary	10	400	....	....	....	185	18	31	200	90	190	155	.....	.....	435	1:4.4	27.46	.....
Turnips test	10	390	....	....	....	172	39	39	196	110	199	165	13.13	8.99	468	1:4.1	29.58	21.16
Preliminary	10	80	320	....	....	164	33	33	164	110	199	178	.....	.....	434	1:4.5	27.58	.....
Mangels test	10	....	400	....	....	171	32	32	160	110	198	182	13.46	9.10	436	1:4.5	27.71	19.33
Preliminary	10	....	160	148	....	123	23	23	140	103	148	181	.....	.....	370	1:4.8	23.69	.....
Sugar Beets test	10	....	....	280	....	135	19	31	158	110	171	178	11.97	8.90	450	1:4.9	29 08	21 56
Preliminary	8	....	....	84	140	106	16	32	12-	88	135	139	.....	.....	341	1:4 6	26.27	.....
Red Beets test	9	....	....	....	252	114	18	36	144	99	152	158	11.17	7.90	367	1:4.6	25.59	19 24
Totals												1336	49.73	34.89	3291	.....	.....	.....
Averages per day											18	17.3	1 27	.89	42.86	1:4.6	27.12	20.32

Table No. 8.—Holstein Cows, 105, 166, 172 and 703,

PERIOD	Days in Period	Turnips	Mangels	Sugar Beets	Red beets	Fodder	Oil Meal	Gluten Meal	Bran	Hay	Lbs Milk per Cow				Lbs. Butter Fat per Cow				Lbs dry Matter Eaten	Dry Matter per 1000 lbs Wt.	Dry Matter Per lb Butter Fat	Nutritive Ratio
											172	166	703	105	172	166	703	105				
Prelim.....	10	800	...	....	..	367	36	63	400	180	413	260	356	2 5	.....	.....	.....	.....	871	18 08	.....	1:4.4
Turnips test ..	10	780	...	....	....	345	78	78	392	220	390	334	390	25[illegible]	13.65	8.85	14.43	8.41	9[illegible]5	19.24	20.62	1:4.1
Prelim.....	10	120	640	....	...	422	84	84	422	220	411	338	409	252	.....	.....	.....	.....	1037	21.78	.....	1:4.4
Mangels test..	10	...	800	....	...	445	84	84	420	220	445	333	406	244	13.13	8.66	13.80	7.81	1057	22.11	24.35	1:4.5
Prelim.....	10	...	320	480	...	418	83	83	4[illegible]2	220	454	333	406	24[illegible]	.....	.....	.....	.....	1064	21 99	.....	1:4.6
S. Beets.....	10	...	...	800	...	392	80	80	420	220	451	342	407	239	13.53	8.55	13.43	7.29	1071	22.17	25.02	1:4.7
Prelim.....	8	...	...	240	400	406	64	64	336	176	325	234	307	180	.....	...	.....	.....	847	21.78	.....	1:4.6
Red Beets test.	9	...	...	.....	720	356	72	72	378	198	373	257	342	208	11.00	6.81	11.63	6.86	956	21.65	26.34	1:4.2
Totals.....											3262	2431	3023	1856	51.31	32.87	53.29	30.37	7838	.....	.....	.....
Averages per day.....											42.3	31.5	39.2	24.1	1.[illegible]1	.84	1.36	.78	101.7	21.1	24.08	1:4.4

It will be seen by consulting the columns of "lbs. butter fat per cow" in each table that the Short-horns and Jerseys have exactly the same amount of butter fat per cow per day for the seventy-seven days, 1.08 pounds, and that the Holsteins have 1.07 pounds, which with one-sixth added as a butter conversion factor, makes, dropping fractions, 1.25 pounds of butter per cow per day. The difference between the breeds is very little, looking at the product. The cost of a pound of butter, however, depends upon the feed consumed. Comparing the two Short-horns with the two Jerseys it will be seen that the Short-horns ate 3800 pounds of dry matter while the Jerseys ate 3291 pounds. Both breeds were fed up to their limit. The Short-horns ate most oil meal, fodder and bran which made a slightly wider nutritive ratio for the Jerseys that consumed as much hay, the Short-horns ratio being 1:4.4, while that of the Jerseys was 1:4.6. During the same time the Short-horns gained ninety pounds in weight, while the Jerseys made no gain whatever. A comparison of the Jerseys with the Holsteins will show very nearly the same contrast. The Holsteins gained 166 pounds for four head which is nearly the same average per cow as the gains of the Short-horns. We have, then 509 pounds of dry matter eaten by the Short-horns more than was eaten by the Jerseys; against the ninety pounds of weight made by the Short horns. But 509 pounds of dry matter fed to the Jerseys made twenty four pounds of butter fat, which at 10.4 cents a pound, the cost of fat by the Jerseys, is $2.50 against the ninety pounds of gain made by the Short-horns.

This presents to us the special, and general purpose breeds. It is evident that whoever wants his product in milk, woul favor the one, and whoever desires fattening tendendencies would favor the other.

The value of the dairy cow with no disposition to fatten is apparent when the ration used was more nitrogenous than

is usually fed in the corn belt, and that, wider rations with corn as a prominent feature would induce still more to fattening. Corn was not fed in this experiment owing to the scarcity and high price. Easy fattening is an element of value where the dairy cow is to be put in good condition during the winter for good work on grass during the summer, or when she is bought for service in the dairy for one season only; to be turned over to the butcher instead of being held over a dry interval, or where calves for feeding are desirable, but, where none of these objects are in view, the tendency to gain considerable weight during the period of lactation is not valuable and not desirable and may be decidedly objectionable. The nutritive ratios in the tables show what will not make gains on Jerseys and only minimum gains on Holsteins and Shorthorns. The nutritive ratio means the relation the digestible protein has to the digestible carbhydrates. A safe guide to follow in feeding is to use feed similar in composition to the product expected. Our rations in this experiment are similar to that of milk.

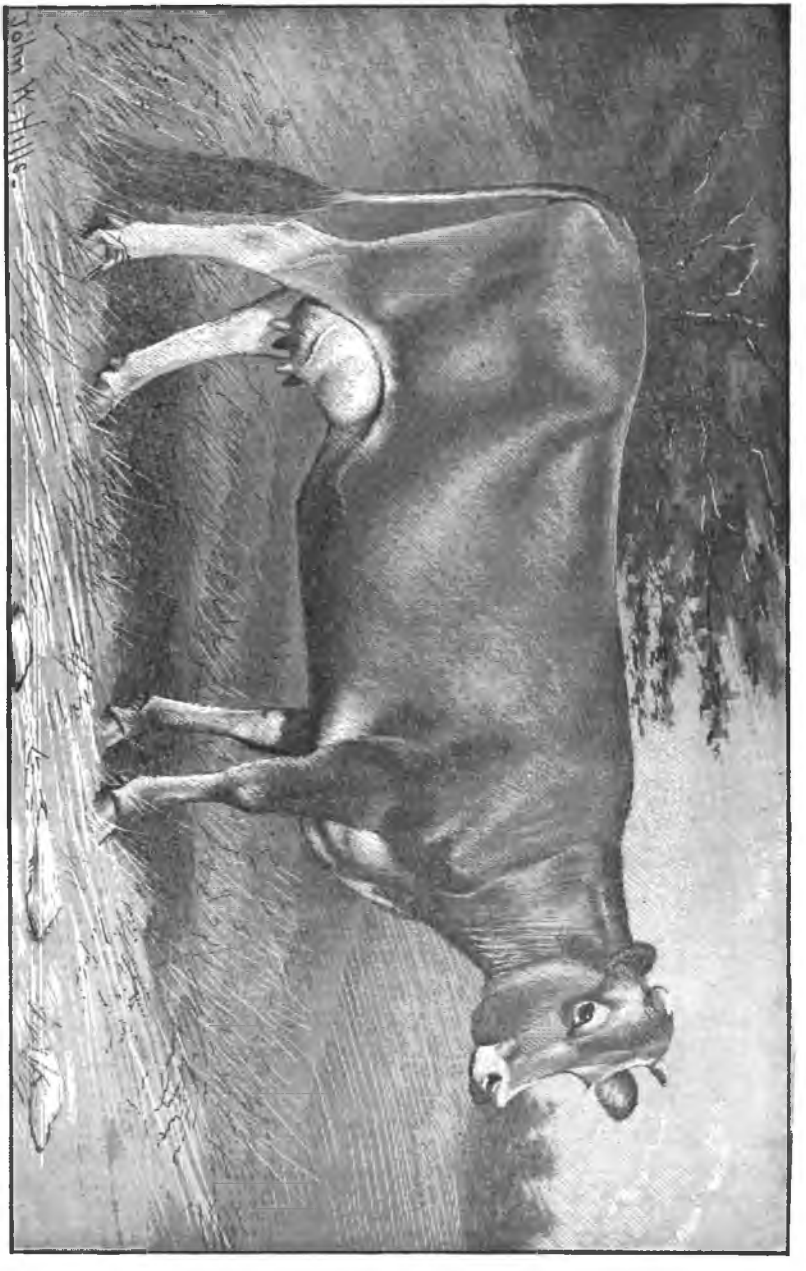
COST OF BUTTER FAT.

The cost of a pound of butter from the Short-horns—not estimating the gains in weight—was 12.7 cents; from the Jerseys 10.4; and from the Holsteins 12.9 cents.

The following prices are used in finding the cost of a pound of butter fat.

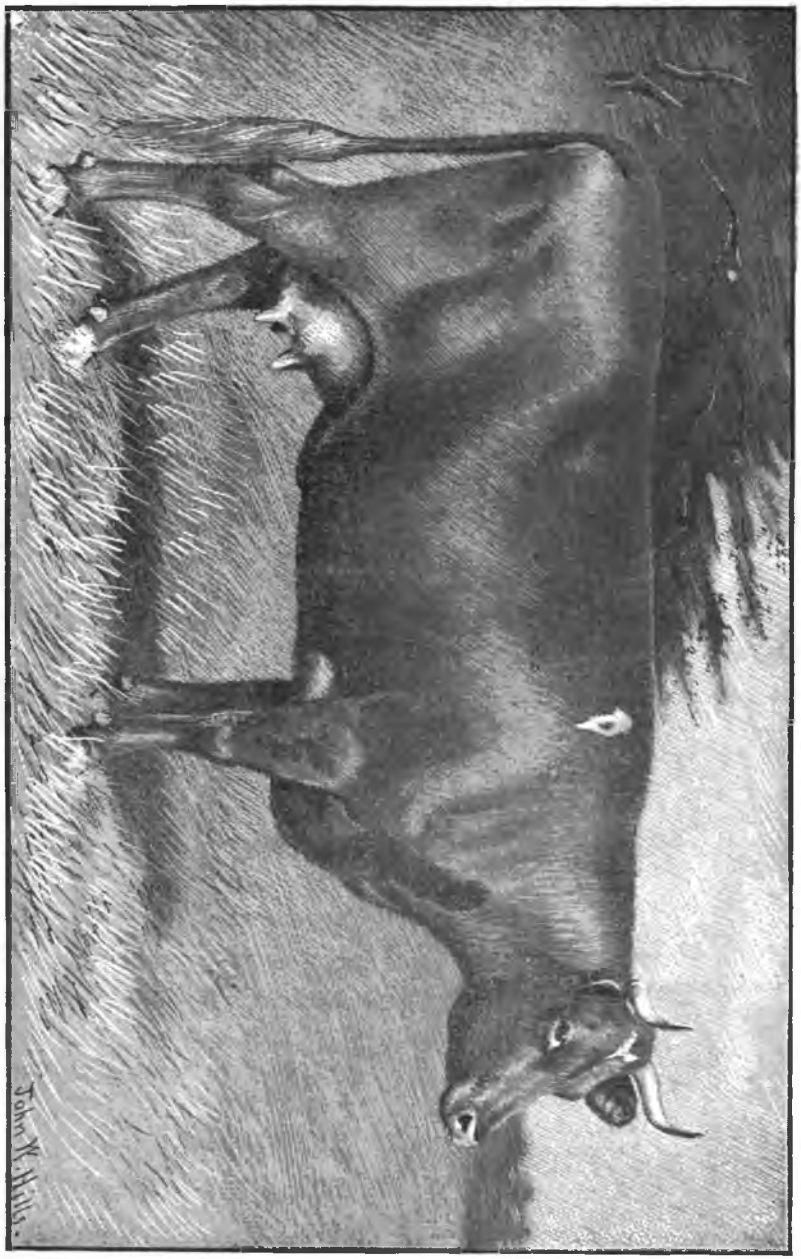
Fodder	.20	cents per cwt.
Bran	.70	" " "
Gluten meal	.75	" " "
Oil meal (old process)	$1.25	" " "
Roots	.05	" " "
Hay	.35	" " "

The following is a cut of Jersey cow 352, (Nicolette 65992, A. J. C. C.) used in this experiment.



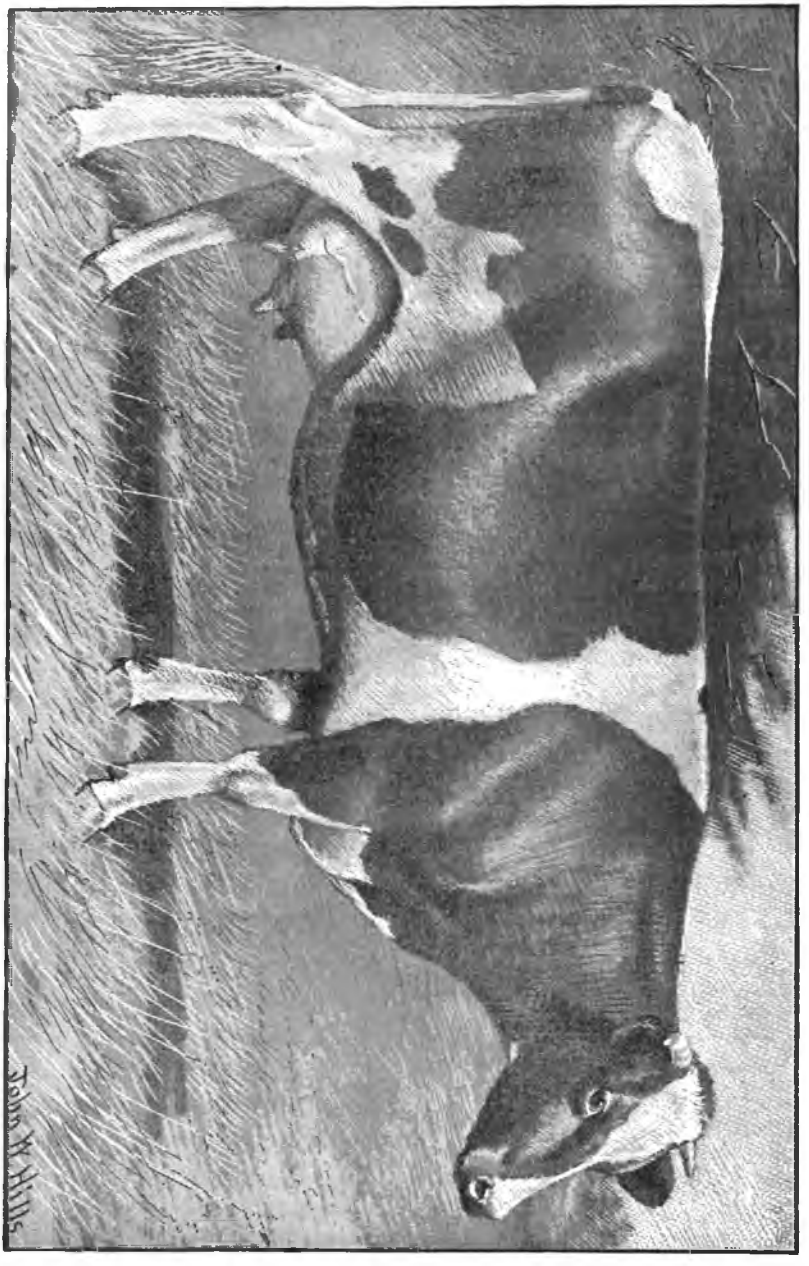
She gave an average of eighteen pounds of milk per day during seventy-seven days, the average test of which was 6.93 per cent. fat Her milk varied during the four root periods from 19.9 pounds a day with 6.60 per cent fat in the turnip test ten days, to 17 pounds a day with 7.35 per cent fat in the red beet period. Her record name is Nicolette, 65992 A. J. C. C. Her dam came from Mr. Richardson of Davenport. Her milk has tested 7.8 per cent fat. She is a typical Jersey weighing 760 pounds at the beginning of the experiment, and made no gain in weight while being fed to her limit of capacity.

The following cut is Short-horn cow 209 (Belle of Squaw Creek, A. S. H. H. B. Vol. 36.) used in this experiment.


John W. Hill.

She gave an average of 31.4 lbs. of milk a day for seventy-seven days, with an average of 3.71 per cent of butter fat. Her yield varied from 33.5 pounds of milk daily with 3.80 per cent fat in the turnip ten days test period, to 27.7 in the red beet period with 3.80 per cent. fat; the per cent fell to 3.60 in the mangel period and was 3.65 in the sugar beet period. During the seventy-seven days she gained seventy pounds in weight. She weighed 1230 pounds when the experiment begun. She is a typical milking Shorthorn. Her dam has figured in our bulletins as cow 244, a heavy milker that fattened easily to 1400 pounds. The family has been on the college farm several generations, and have been used as dairy cows. Her calves would make show cattle if fed for that purpose. She would lay on fat rapidly on a corn ration, of wider nutritive ratio.

The following cut is Holstein cow 703 (Princess of Black Hawk 39385 H. F. A. A.) used in this experiment.


John W. Hills

She gave an average of 39.2 pounds of milk, of 3.45 average per cent of butter fat, during the seventy-seven days of root feeding. Her milk varied from 3.70 per cent of fat in the turnip period to 3.30 in the sugar beet period. She gained forty pounds in weight in the seventy-seven days. The table shows her butter fat daily to be 1.36 pounds, or 1.58 pounds of butter. The Jersey has a daily average of 1.27 pounds of butter fat or 1.48 pounds of butter; but the Holstein ate 314 pounds of dry matter more than the Jersey, which makes the Jersey's butter the cheaper. The Shorthorn has a credit of 1.15 pounds of butter fat or 1.34 pounds of butter. The three cows are fair averages of the college herd, neither the heaviest milkers nor the lightest of the breeds to which they belong.

The following table shows the per cent of butter fat of the eight cows during the thirty-nine test days of the seventy-seven day period.

Per cent of Fat in Milk of Individual Cows.

Cow No.	TURNIP	MANGEL	SUGAR BEET	R. T. BEET	Average
	Period I.	Period II	Period III.	Period IV.	
352	6.60	6.60	7.00	7.35	6.93
703	3.70	3.40	3.30	3.40	3.45
172	3.50	2.95	3.00	2.95	3.10
209	3.80	3.60	3.65	3.80	3.71
354	5.45	5.00	5.00	5.00	5.11
200	4.15	3.95	4.25	4.30	4.16
166	2.65	2.60	2.50	2.65	2.60
105	3.30	3.20	3.05	3.30	3.21

DRY MATTER.

This means the feed of all kinds computed on the basis of absolute exclusion of moisture.

During the seventy seven days of root feeding a pound of butter fat was had from 24.08 pounds of dry matter fed to the Holsteins; from 23.46 pounds of dry matter fed to the Shorthorns; and from 20.32 pounds of dry matter fed to the Jerseys.

An average for all the cows is 22.95, during the thirty-nine test days; and a gain in weight of 256 pounds during the 77 days. No credit is given here for gains in weight, to the Holsteins or Short-horns, that diverted part of the nutriment to their bodies.

The dry matter eaten for each 1000 pounds of live weight was for the Holsteins 21.19 pounds; for the Short-horns 19.87 pounds and for the Jerseys 27:12 pounds. The average of the three breeds was 22+ pounds. The Jerseys have the greatest consuming capacity based on weight.

By consulting table No, 1, it will be seen that 20.51 lbs. of dry matter made a pound of butter fat, when turnips were being fed resulting in a loss of sixty pounds of weight on the eight cows.

During the feeding of mangels 23.01 pounds of dry matter were required for a pound of butter fat, but the cows gained 110 pounds in weight.

In the sugar beet period 23.83 pounds of dry matter were required to make a pound of butter fat, while the cows lost slightly in weight.

With red table beets 24.45 pounds of dry matter were required to make a pound of butter fat, but the cows made gains in weight during the nine days of 136 pounds.

* * *

The cows were then divided into two lots for observations during forty-six days when roots were substituted by their equivalent of dry matter in additional bran, the ration being wet twelve hours before feeding for one lot and fed dry to the other.

Tables 9 and 10 will show the results from this feeding. It began March 19, and extended to April 19, when the lots were reversed. The cows were fed the same as they had been in the seventy-seven day root periods, excepting the substitution of bran for roots.

SUMMARY OF WET AND DRY FEED.

PRELIMINARY AND TEST PERIODS

TABLE No. 9—Dry Feed Lot. Cows No. 166, 209, 172, 354.

DATES INCLUSIVE	PERIOD	Mangels	Fodder	Bran	Oil meal	Gluten meal	Hay	Water mixed with feed	Days in period	Lbs. Milk	Lbs. butter fat	Lbs butter	Lbs. butter per cow per day	Lbs dry matter eaten	Nutritive ratio	Gain in weight	Dry matter per 1000 lbs. w't per day.	Lbs. dry matter per lb of butter fat
March 19 to 29	V Preliminary	109	372	504	79	85	242	406	11	1175				1025¼	1:4.3	—70	20.11	
March 30 to April 9	V Test period		406	528	88	88	187		11	1099	36.44	42.51	.96	1017 4-5	1:4.2			27.93
April 10 to 18	VI " "		321	432	72	72	198		9	862	30.49	35.57	.98	865	1:4.3	60	20 33	28.37
April 19 to 23	VII Preliminary		180	240	40	40	110	156	5	484				481½	1:4.2			
April 24 to May 3	VII Test period		344	480	80	80	220	560	10	933	29 35	34.24	.85	953.9	1: .4	00	20.44	32.5
									46							-10		

TABLE No. 10—Wet Feed Lot. Cows No. 703, 200, 105, 352.

March 19 to 20	V Preliminary	109	352	496	78	84	242	606	11	1031				1005.13	1:4.3	—86	20.94	
March 30 to April 9	V Test Period		402	528	88	88	187	616	11	988	40 80	47.60	1.08	1015.86	1:4 2			24 89
April 10 to 18	VI " "		304	432	72	72	198	504	9	793	34.25	39.95	1.11	865 41	1:4.2	80	21 45	24.97
April 19 to 23	VII Preliminary		184	240	40	40	110	124	5	424				486.85	1:4 2			
April 24 to May 3	VII Test period		275	480	80	80	220		10	808	31.25	36.45	.91	914.05	1:4 3	30	21.11	29.24
									46							24		

These two tables nine and ten show that roots were stopped, that butter fat decreased, that more pounds of dry matter were required to make a pound of butter fat, and that the cows did not gain in weight during the forty-six days, leading us to the conclusion that the lack of roots interfered with digestibility or assimilation. The cows were divided into two lots, one lot had their ration mixed with water twelve hours before feeding, the other was fed a dry ration. The difference between the two lots is not striking. There is a small per cent in favor of the wet feed, but the increase in the amount of dry matter required to make a pound of butter fat with only fourteen pounds increase, during the forty-six days, in the weight of the eight cows is striking. The seventy-seven day period with roots demonstrates that the Holsteins and Shorthorns gained weight on mangels and red beets very promptly, and the Jerseys also gained on red beets. The disposition to lay on fat is clearly established for all three breeds on this root, at the expense of butter fat, the total fat for ten days, being 85.11 on sugar beets and 80.6 on red beets, but, the cows lost 5 pounds on sugar beets, and gained 151 on red beets, on a ten day basis.

There are three test periods in the two tables, nine and ten. The first was from March 30 to April 9, the second from April 10 to April 18. In table nine, four cows had dry feed, and in table ten, for the same time four cows had wet feed, the tables show the results. Averaging the dry matter of both tables it is seen that in the first period of eleven days 26.41 pounds of dry matter were required to make a pound of butter fat, and during the second period of eleven days 26.67 pounds of dry matter were required to make a pound of butter fat.

During the third test period from April 24 to May 3 the cows in table nine were given wet feed, and those in table ten were given dry feed and 30.87 pounds of dry matter were requir-

ed to make a pound of butter fat. The rations were as nearly the same as could be fed during both the seventy-seven day root periods, and the forty-six day periods without roots, excepting that, the dry matter of the roots was substituted with bran as nearly as the appetites of the cows would permit. But during the thirty test days of the forty-six day period without roots, 27.75 pounds of dry matter were required to make a pound of butter fat and 14 pounds gain in weight while, as has been seen only 22.95 pounds were required during the thirty-nine test days of the seventy-seven day period with a gain in weight in addition of 256 pounds.

GRAZING PERIOD.

The cows were turned to pasture May 4th, and were under observation for sixty-six days. They gained 345 pounds during that time. They were fed part of the time on grass with bran and part of the time on grass alone. As soon as grazing began there was an increase in milk and butter fat and also gains in weight equal to 5 pounds daily for the eight cows. The object of the grazing period was to note the effect of feeding bran with pasture, which indicates improvement over yield on grass alone. The work will be repeated with fresher cows and with grains, and by-products. I call attention to it now on account of the gains of the cows that had ceased adding to their weight during the forty-six day period without roots.

RECORD OF COWS IN DAIRY EXPERIMENT BEGUN JAN. 1, 1895.

No. 703, Holstein, calved Sept. 10, 1894, bred Nov. 24, 1894.
" 105, Holstein, " " 14 " not bred.
" 166, Holstein, " Oct. 4, " bred Dec. 29, 1894.
" 209, Short-horn, " Nov. 7, " not bred.
" 200, " " Nov. 9, " not bred.
" 352, Jersey, " Dec. 7, " not bred.
" 354, " " Sept. 17. " bred Dec. 2, 1894.
" 172, Holstein, " Dec. 7, " not bred.

The following table shows the volatile acids and melting point of butters produced when the four roots were fed.

TABLE No. 11.

Volatile Acids and Melting Point of Butter Fat.

	Turnip period	Mangel period	Sugar beet period	Red beet period
*Volatile acids..	31.1 c. c.	31.46 c. c.	30.52 c. c.	29.61 c. c.
Melting point—degrees C.....	32.43	32.35	32.25	32.70
Flavor ..... (points out of 45)	38	42.5	43.5	43

*Five grammes dry butter fat.

We can not ignore this factor present in some forage crops. The analyses for turnips and mangels are similar to what has been previously found at this station. (Bulletin 25.) The turnips have an injurious flavor as shown by a score of 38 in a possible 45 for the butter made from them. The mangel butter has a score of 42.5 which brings it within the range of fine butters. The sugar beet and red table beet score high, going up among the roots that have no bad volatile acids that injure the flavors of butter. Much has been said about methods of feeding turnips, cabbage and other roots and tops so as to avoid the influence of the acids contained in them. An experiment conducted during the present winter along this line where cabbage and turnips were fed after milking gives strong indications that this injurious feature is only gotten rid of by heating the cream up to 160° F which drives off the volatile acid, after which fine butter can be made. An article in this Bulletin by Mr. McKay, Dairy Instructor, elaborates this point.

The following tables show the analysis of sugar beets, and red table beets by Dr. Weems, the Station Chemist.

CHEMICAL ANALYSIS OF SUGAR BEETS.

	As Received per cent	Dry Matter per cent
Water	82.28	
Ether extract (Crude fat)	.07	.42
Crude portein. (Total N x 6.25)	2.05	11.54
Albuminoids (Alb. N. x 6.25)	[.66]	[3.74]
Crude fiber	1.12	6.33
	.91	5.14
Amido substances	[1.39]	[7.80]
Nitrogen free extract	13.57	76.57

CHEMICAL ANALYSIS OF RED TABLE BEETS.

	As Received per cent.	Dry Matter per cent.
Water	83.60	
Ether extract (Crude fat)	.06	.37
Crude portein (Total N. x 6.25)	2.18	13.31
Albuminoids (Alb. N. x 6.25)	[.67]	[4.06]
Crude fiber	.91	5.52
	.97	5.92
Amido substances	[1.51]	[9.25]
Nitrogen free extract	12.28	74.88

The feeding was done by John Hoover, the Station feeder, work in the creamery was done by G. L. McKay, Dairy Instructor, considerable work on the tables was done by C. D. Reed, the farm foreman, to all of whom I am under obligations.