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The Agricultural Experiment Station

OF THE

Colorado Agricultural College.

PART I.

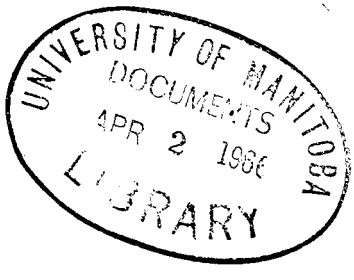
THE FEEDING VALUE OF BEET PULP.

PART II.

FEEDING BEET PULP AND SUGAR BEETS TO COWS.

—BY—

B. C. BUFFUM and C. J. GRIFFITH.



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THE FEEDING VALUE OF BEET PULP AND FEEDING BEET PULP AND SUGAR BEETS TO COWS.

BY B. C. BUFFUM AND C. J. GRIFFITH.

PART I. INTRODUCTION.

The natural conditions in arid America where a comparatively small part of the land is reclaimed by irrigation and the rest will always be used as range for live stock, make the stock industry one of the most important features of our Agriculture. With the development of our irrigated farms has come smaller holdings of better classes of stock than those originally pastured on the ranges, and the farmer has become desirous of finishing his stock for market at home instead of selling feeders to be fattened in the corn growing states east of us.

The growing of alfalfa on our farms to supply a rotation which will keep up the fertility of the soil has become an indispensible practice and this surplus hay is an important item of profit if it can be fed at home.

Establishing the beet sugar industry has brought to our farmers another source of stock foods in the by products of the sugar factories, the most important of which is the beet pulp which is left after the sugar has been extracted. The coming winter we estimate that the factories now established in the state will produce over 150,000 tons of this pulp which will be available for feeding stock. Our farmers are customers for large quantities of corn shipped in from Kansas, Nebraska and Iowa, for which they pay large prices in order to enable them to profitably use their alfalfa in fitting stock, more especially lambs, for market. Anything which will make our own people more independent by producing their own feeds instead of purchasing from abroad is of inestimable value to the state. The Experiment Station is continually trying to solve this problem and furnish the information it may gain to those who can make use of it. The feeding value of sugar beets and of beet pulp, the comparative value of our home grown grains, and corn and of such new grains or new stock foods of whatever nature, and the combinations of these foods which will give the largest returns, are important questions which have been receiving marked at-

tention recently. We are now ready to publish bulletins giving the results of a series of experiments which have been carried out to throw light on these questions. An experiment has been carried out on the sub-station at Rockyford by Mr. Griffin, to show the value of beet pulp combined with alfalfa for lamb feeding. In the present bulletin we give a brief resume of the value of beet pulp as determined in other places and report some trials in which beets and pulp were fed to cows on the College farm at Fort Collins. The information of the value of pulp as determined in other places has been gleaned from every available source which we have reason to believe is reliable and in connection with our own investigations will give our farmers and stockmen some basis upon which to decide whether or not it will pay them to feed pulp to their stock. In addition to this bulletin, we have ready for publication a bulletin on "Swine Feeding in Colorado" which reports trials with beets and pulp and which gives the only information we know of about the value of beet pulp for hog feeding, and also a bulletin entitled "Lamb Feeding Experiments in 1901-1902," in which will be reported the results of our trials of pulp and beets in rations for fattening lambs. We speak only of the diffusion pulp such as comes from our factories.

COMPOSITION OF BEET PULP.

Professor Henry in his book "Feeds and Feeding" gives the result of sixteen analyses and seven trials of digestibility of beet pulp, which shows the following composition. The digestible nutrients are given:

BEET PULP. AVERAGE OF 16 ANALYSES.

Dry Matter.	Protein.	Carbohydrates.	Ether Extract.	Nutritive Ratio.
10.2	0.6	7.3	—	1:12.2

Analyses made by the California Station, published in their bulletins, show a nutritive value considerably higher than the above. These analyses also show the comparative value of beet pulp, pulp silage and sugar beet silage.

The digestible nutrients only were calculated.

CALIFORNIA BEET PULP.

	Water.	Protein.	Carbohydrates.	Fat.	Feed Value Calories.	Nutritive Ratio
Beet Pulp	90	1.25	8.19	0.14	164	1:6.7
Beet Pulp Silage	90	1.46	7.84	0.39	165	1:5.7
Sugar Beet Silage	70	4.38	23.52	1.17	351	1:7.7

Analyses made by Dr. Headden, Professor of Chemistry

at the College, shows our Colorado pulp to have the following composition:

COLORADO BEET PULP.

Dry Matter.	Protein.	Carbohydrates.	Fat.	Nutritive Ratio
10.0	0.38	7.36	0.2	1:20.5

The crude fibre and nitrogen free extract were reported separately but we combine them under carbohydrates. According to the Calfornia analyses, the beet pulp silage has a narrower ratio and a little higher food value than the fresh pulp, which seems to be the general experience in practice. It will be noted that the fresh pulp is apparently worth between one-third and one-half as much as the sugar beet when made into silage.

The places are not given where the analyses reported by Henry were made; possibly they were all from Europe, and if so, it is possible that the diffreence between the beet pulp there and in this country would be as great as that shown. The analysis given in the Report of the United States Department of Agriculture as an average analysis, is about midway between the ones given above.

The nutritive ratio from the analysis is given as 1:7.2, which it is pointed out, is near the standard ratio for a fattening steer, according to the given standard.

The analysis of the Colorado pulp gives a lower amount of protein and a little more carbohydrates and fat than the composition as given by Professor Henry. This makes the nutritive ratio correspondingly wide.

RESULTS OF FEEDING TRIALS.

EUROPE.

Some experiments in feeding pulp in Europe as given in the year book of the U. S. Department of Agriculture for 1898 are of especial interest to us, as the roughage used was alfalfa hay, the ration being enriched by using linseed oil-cake. The following table presents these results. The value per ton of pulp is computed from increase in weight and value of other foods given.

ANIMALS.	FEED.				
	Pulp. lbs.	Alfalfa. lbs.	Linseed Cake. lbs.	Grain per Day. lbs.	Value of Pulp per Ton.
Beef Cattle	115.0	6.6	6.6	2.214	$1.18
Oxen	126.8	12.0	2.2	——	0.87
Sheep	11.8	1.1	0.44	0.3	1.58
Ewes	——	——	——	——	1.10
Average					$1.18

It was stated that the oxen fell off in flesh the first fifteen days on pulp, but after that they gained and did more work on the pulp ration. The ewes were given a little larger ration than the sheep. An experiment in feeding milk cows was said to be even more satisfactory but the comparative value of the pulp was not indicated.

CALIFORNIA.

The California Experiment Station has published some general statements regarding the value of pulp. Different stockmen replied that they could afford to pay from 25 cents to $1.00 per ton for beet pulp. One man placed the value of fermented pulp at 25 cents per ton more than fresh pulp. The pulp there is fed with oat and barley hay and straw, along with chopped grain and cottonseed meal. It is claimed that the meat dresses whiter and with less sinews when fed pulp. An experiment is reported in which pulp was fed to cows and its effect on feed consumed, milk flow and butter fat noted. An accurate account of the hay was not kept, but approximately when no pulp was fed, the cows consumed twenty pounds of hay per day, in addition to eight pounds of grain. When given pulp, the consumption of hay varied from 6 to 16 pounds, depending upon the amount of pulp, which varied from 20 to 80 pounds per day. The effect on the milk flow was beneficial, but there was no appreciable effect in raising or lowering the proportion of fat in the milk.

MICHIGAN.

The Michigan Experiment Station has carried out some interesting experiments in feeding beet pulp. In one experiment pulp was fed to steers at the rate of 55 pounds per day along with mixed hay, shredded corn stover and ground grain. The amounts of foods given and eaten were compared with a check lot not given pulp. It was found that one ton of pulp took the place of 421.5 pounds of corn stover, 274 pounds of mixed hay and 68.8 pounds of grain. At Colorado prices of $4.00 per ton for the roughage and 1¼ cents per pound for the grain, this would give the pulp a value of $2.25 per ton.

In another experiment 13,775 pounds of pulp gave an increased gain of 280 pounds of beef. Giving the increased gain a value of 7½ cents per pound would indicate that the feeding value of the pulp was a little more than $3.00 per ton.

Experiments with milk cows showed that the pulp, when given with hay and grain, increased the flow of milk some-

what but did not add to the yield of butter fat. This report states that owners of growing and fattening cattle declare that pulp saves one-third of the coarse fodder.

NEW YORK.

The Cornell Station reports experiments in feeding beet pulp to cows. Their conclusions are as follows:

"The cows, as a rule, ate beet pulp readily and consumed from 50 to 100 pounds per day, according to size, in addition to the usual feed of 8 pounds of grain and 6 to 12 pounds of hay."

"The dry matter in beet pulp proved to be of equal value, pound for pound, with the dry matter in corn silage."

"The milk producing value of beet pulp as it comes from the beet sugar factory is about one-half that of corn silage."

"Beet pulp is especially valuable as a succulent food, and when no other such food is obtainable it may prove of greater comparative value than is given above."

In the dairy districts of New York and other states where factories have been established, beet pulp is coming into great demand for cows.

NEBRASKA AND OTHER PLACES.

In New Mexico, sheep, and in Utah, cattle, have been successfully fattened and put on the market with no other food than pulp and alfalfa hay.

In Nebraska some valuable data has been obtained with both sheep and cattle. Experience there indicates that a maximum amount of 40 or 50 pounds pulp per day for each steer gives better results than larger amounts. Mr. John Reimers, whose report on pulp feeding has been often quoted, states that cattle eat the same amount of hay and grain when given only moderate amounts of the pulp, but that they lay on flesh more rapidly, shortening the feeding season, and that the pulp gives extra gains of from 50 to 75 pounds in three-fourths of the usual time, which results in a great saving of grain and roughness. His pulp-fed cattle dressed and shipped as well as any other, even for export. Many general reports have been made by those who have fed this important by-product of the sugar factories and all testify to its value both for fattening and the production of milk.

In Colorado some extensive feeding has been done with with pulp. Several feeders in the Arkansas Valley have fed large quantities to both sheep and cattle during the past two years. Col. J. A. Lockhart at Rockyford fed 3,700 head of

cattle during the past winter using beet pulp, alfalfa hay, sorghum, cotton seed meal, corn and bran. He has kindly offered to furnish the Station with his results, and as the feeding was done on so large a scale the data obtained will be very valuable. Mr. Rhodes, of Las Animas, fed 2,200 lambs on pulp, and speaks very highly of the pulp. There was practically no loss of lambs, they made large gains, and he states that the saving of hay while they were receiving the pulp was very marked. Several feeders at Loveland, Colorado, who fed pulp last season will feed on a larger scale the coming winter. Mark Austin, the Agricultural Superintendent for the Loveland Sugar Factory, profitably fed lambs and cattle, and Wm. Davis, a farmer north of Loveland, tells us that his cattle did exceeding well on the pulp ration.

USE OF PULP.

It should be stated that the attempts to compute the cash value of pulp compared with other foods do not indicate its total value. It supplies a succulent food at a time when such food is either not available or is scarce, and its effect on stock seems to be much more favorable than either its chemical analysis or the return in increased meat or milk would indicate. To its actual nutritive effect as a food should be added its general effect on the quality of meat and milk and on the animal system. Pulp undoubtedly overcomes much injurious effects of dry and concentrated foods, puts the system in good sanitary condition, keeps off disease, and so aids the appetite and digestion and assimilation of food that there is less waste, both of food which is generally discarded in eating, and that which usually passes through the animal undigested.

There seems to be no difficulty in regard to keeping beet pulp. While there is some loss of material when placed in open piles, the fermentation which takes place seems to be beneficial rather than otherwise. Animals eat the sour pulp as well, and after a little time even better than they do the pulp fresh from the factory, and the dry beet chips on the surface of the piles are very palatable to sheep and cattle. Nebraska feeders claim that pulp which has been left in open piles for two or three years is as good as ever.

No injurious effects have been observed from feeding pulp, unless too large amounts are given before the animals become accustomed to it. The Michigan Station warns feeders against too liberal use of pulp from frozen beets. Freezing does not seem to injure the pulp itself, except that it

probably does not pay to feed large amounts of frozen pulp in cold weather, as the animal must expend much food energy to raise the temperature of the pulp to the heat of the body. Utah reports a case of the pulp becoming poisoned in shipping. The pulp was shipped in freight cars which had been used in shipping lead ores from the mines, and the pulp absorbed enough of the lead to make it dangerous to stock.

During the past spring the Denver papers gave an account of cattles' mouths becoming sore from eating pulp, claiming that the injury was produced by acids added to the pulp in the process of manufacture. This is hardly possible, as the pulp is subjected to nothing but hot water at the factory. Through the process of fermentation from long keeping butyric and acetic acids develop in pulp, but we have no accounts of any injurious effects from feeding fermented pulp.

The greatest difficulty with pulp feeding is that the large amount of water it contains makes it heavy and rather expensive to handle, and it is sometimes difficult to keep the animals dry and comfortable while feeding large amounts of it. The feeder who is near the factory and has the appliances so arranged that he can handle the pulp with the least expense, should make the greatest use of pulp and will gain the greatest profit from its use. If it can be placed before stock at a cost of not more than one dollar per ton, we believe it will bring good returns for the investment, and in many instances it may be worth two or three times this amount. Whether fresh, fermented, or dry, beet pulp is a valuable stock food, and one of which our farmers should make the largest possible use.

As an example of how pulp may be combined with other foods in forming a ration, we give the following illustration:

RATIONS WITH BEET PULP.

FATTENING CATTLE WEIGHING 1,CCO POUNDS.

FIRST PERIOD.

	Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Standard Ration.....	30	2.5	15.0	0.5	1:6.5
Alfalfa.....15 lbs.	13.7	1.65	5.94	0.18	
Beet Pulp.....75 "	7.6	0.45	5.47		
Cotton Seed Meal 2 "	1.8	0.75	0.3	0.24	
	23.1	2.85	11.71	0.42	1:4.4

SECOND PERIOD.

		Dry Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Standard		30	3.0	14.5	0.7	1:5.4
Alfalfa	15 lbs.	13.7	1.65	5.94	0.18	
Beet Pulp	25 "	2.5	0.15	1.8		
Cotton Seed Meal	2 "	1.8	0.75	0.3	0.24	
Corn Meal	6 "	5.36	0.46	4.0	0.26	
		23.36	3.01	12.04	0.68	1:4.5

The larger part of the above information has been gleaned from the following authorities:

Colorado Experiment Station Bulletin No. 46.
Cornell Experiment Station Bulletin No. 183.
California Experiment Station Bulletin No. 132.
Michigan Experiment Station Bulletin No. 193.
Yearbook U. S. Department of Agriculture 1898.
Special Reports, Division of Chemistry, U. S. Department of Agriculture, 1897, 1898, 1899.
Utah Experiment Station Bulletin No. 74.

FEEDING BEET PULP AND SUGAR BEETS TO COWS.

PART II. INTRODUCTION.

The experiments here reported were among the first planned to compare the feeding value of sugar beets and pulp from beet sugar factories. The value of roots to furnish succulent food during the winter when green pasture is not available, has long been well understood, and such succulent foods are considered especially desirable for cows producing milk. The pulp has a smaller nutritive value than beets because the sugar and salts which have been extracted at the factory are important food products, but there is no question about its succulence. Fresh pulp contains about ten per cent more water than beets. If the office of roots in a ration is to supply juicy foods which will aid in the digestion and assimilation of the roughage and grain fed with it, rather than for the nutritive effect, we would expect pulp to possess the necessary qualifications. The manufacture of silage from corn and other roughage is done to extend the summer conditions of green food through the rest of the year when the animal's system is apt to become clogged with dry grain and dry hay to such an extent that the digestive tract does not perform its normal function.

That the main use of roots or beet pulp is to prevent mal-nutrition and insure general health, rather than to supply food, can hardly be questioned. Food nutrients can be supplied in concentrated form, but in order for the animal to make use of them he must be given bulk to fill up and distend the digestive organs, and the food must be porous and permeable by the digestive fluids. Laplanders eat infusorial earth, which is simply a chalky soil, to help fill up the stomach and dilute the whale blubber which is almost pure fat and forms the chief part of their diet.

Beets or beet pulp given our farm animals supply quantities of tender living plant cells which are filled with juices and which dilute, soften and separate the particles of dry hay and grain so the nutritive qualities of the whole may be more efficiently digested and absorbed out of the mass. This is aptly illustrated by a statement made to one of us by a feeder of long experience. He stated that one winter he followed the usual practice of running hogs with his steers to

consume the undigested corn. The hogs did usually well until he added the beet pulp to the corn ration for the steers, when they so thoroughly digested the corn that the hogs starved and he was forced to give them other food.

Both beets and pulp have nutritive values, that of the beets being greater than that of the pulp. They contain so much water which is merely bulk, that a cow would hardly be able to eat enough of the pulp, at least if given no other food, to supply her maintenance, and there is a limit to the amount of such foods which can be profitably used. Some experiments report cows eating as much as 120 pounds of pulp daily, or forty to sixty pounds of beets. However, excessively large amounts of beets are dangerous, as they contain small amounts of a poison principle which may cause the death of the animal by paralysis, if indeed the mere amount of food does not produce other serious troubles. In all of our experiments up to this time we have confined the amount of beets or pulp fed to a minimum, giving only such quantities as experience in other places has indicated could be fed with profit. We think fifty pounds of beet pulp, or one-half that amount of beets, would be a maximum to add to a ration fed to cows, and in our experiments to show comparative values we have fed approximately one-half as much.

If the main use of beets or pulp is to furnish a tonic or to produce a salubrious mechanical effect, rather than to supply nutriment, then we would not expect to find a great amount of difference in their feeding value when added to grain and hay rations in small amounts. These points should be borne in mind when comparing the results obtained in the following reports of our feeding trials.

The beets fed were grown on the College farm and contained from twelve to seventeen per cent of sugar. The pulp was kindly furnished for the purpose of making the tests by Mr. A. V. Officer, manager of the Loveland Sugar Factory. The pulp was placed in piles on the ground outdoors and fed as wanted.

PLAN OF THE EXPERIMENT.

At first four cows were put on alternate beet and pulp rations, records of which were kept for eleven weeks. Later a fifth cow, Bessie Geneva 2d, was added and fed from the eighth to eleventh weeks. Having obtained five common stock cows before the supply of pulp was exhausted, they were fed in the same manner the last three weeks.

The first week all the cows were given sugar beets; the next two weeks the beets were discontinued and pulp fed;

the fourth and fifth weeks beets were given instead of pulp; the sixth and seventh weeks pulp was fed; the eighth and ninth weeks, beets, and the tenth and eleventh weeks, pulp. The cows were all fed the same amount of hay and grain daily throughout the experiment. The grain was equal parts of corn chop and wheat chop.

There was a slight variation the first week in the amount of grain fed, as the cows were given four pounds of grain per day the first two days, at the end of which time it was increased to eight pounds per day. The first week each cow ate 14.3 pounds of alfalfa per day, and for the remaining time they ate 20 pounds per day. The sugar beets eaten amounted to eight pounds per day during the first week, and twelve pounds per day during the subsequent alternate periods of two weeks each. They ate 24 pounds of pulp daily when given the pulp ration. The rations were as follows:

BEET RATION.

Corn chop, 4 pounds.
Wheat chop, 4 pounds.
Alfalfa hay, 20 pounds.
Sugar beets, 12 pounds.

PULP RATION.

Corn chop, 4 pounds.
Wheat chop, 4 pounds.
Alfalfa hay, 20 pounds.
Beet pulp, 24 pounds.

It is interesting to note how nearly the above rations correspond in digestible nutrients with the theoretical standard for a thousand pound dairy cow giving 22 pounds of milk daily.

	Dry Matter.	Protein.	Carbo-hydrates.	Ether Extract	Ratio.
Standard	29	2.50	13.0	0.5	1:5.7
Our Beet Ration	27.1	3.05	14.6	0.5	1:5.1
Our Pulp Ration	27.8	2.99	14.2	0.48	1:5.1

RESULTS OF THE FEEDING TRIALS.

Tables I to X give the individual records of each of the cows which were fed either beets or pulp for two or more weeks, and Tables XI and XII give in condensed form the records of the five cows which were fed beets one week and pulp two weeks. The minus sign before numbers in columns headed "gain" means a loss of weight for the time indicated.

TABLE I.

DAINTY NOBLE—FED SUGAR BEETS.

Week.	Weight of Cow.			Beets Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
1st.	800	820	20	56	118.0	6.46	4.65
4th and 5th.	820	870	50	168	244.2	13.91	4.87
8th and 9th.	890	830	—60	168	244.5	14.59	5.12
Total.			10	392	606.7	34.96	
Average Weekly.			2	78.5	121.3	6.99	4.88

TABLE II.

DAINTY NOBLE—FED BEET PULP.

Week.	Weight of Cow.			Pulp Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
2d and 3d.	820	820	0	224	246	13.89	4.85
6th and 7th.	870	890	20	336	242.2	13.34	4.72
10th and 11th.	830	880	50	336	252.5	15.17	5.16
Total.			70	896	740.7	42.40	
Average Weekly.			11.7	149.3	123.5	7.06	4.89

TABLE III.

GILDANA—FED SUGAR BEETS.

Week.	Weight of Cow.			Beets Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
1st.	930	931	1	56	59.0	3.19	4.60
4th and 5th.	960	970	10	168	144.2	8.15	4.84
8th and 9th.	960	970	10	168	133.0	7.80	4.93
Total.			21	392	336.2	19.14	
Average Weekly.			4.2	78.5	67.2	3.83	4.79

TABLE IV.

GILDANA—FED BEET PULP.

Week.	Weight of Cow.			Pulp Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
2d and 3d.	931	960	29	224	136.5	7.6	4.79
6th and 7th.	970	960	−10	336	121.7	7.03	4.95
10th and 11th.							
Total			19	560	258.2	14.63	
Average Weekly.			4.7	140	64.5	3.66	4.87

TABLE V.

YOUNG GRANNIE—FED SUGAR BEETS.

Week.	Weight of Cow.			Beets Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
1st.	1070	1060	—10	56	91.5	5.28	4.95
4th and 5th.	1090	1080	—10	168	210.5	12.52	5.10
8th and 9th.							
Total.			—20	224	302.0	17.80	
Average Weekly.			—6.6	74.7	100.7	5.93	5.02

TABLE VI.

YOUNG GRANNIE—FED BEET PULP.

Week.	Weight of Cow.			Pulp Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
2d and 3d.	1060	1090	30	224	203.2	11.68	4.94
6th.	1080	1108	28	168	104.5	5.98	4.89
Total.			58	392	307.7	17.66	
Average Weekly.			19.3	131	102.6	5.88	4.91

TABLE VII.

MOUNTAIN BEAUTY—FED SUGAR BEETS.

Week.	Weight of Cow.			Beets Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
1st.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
4th and 5th.	970	970	0	168	163.0	7.07	3.51
8th and 9th.	1000	1030	30	168	190.2	7.71	3.47
Total.			30	336	353.2	14.78	
Average Weekly.			7.5	84	88.3	3.69	3.49

TABLE VIII.

MOUNTAIN BEAUTY—FED BEET PULP.

Week.	Weight of Cow.			Pulp Eaten	Milk	Butter	Percent Fat
	Beginning	End	Gain				
2d and 3d.	lbs. 960	lbs. 970	lbs. 10	lbs. 224	lbs. 146.7	lbs. 6.43	3.72
6th and 7th.	970	1000	30	336	178.2	7.43	3.57
10th and 11th.	1030	990	—40	336	192.0	7.65	3.43
Total.			00	896	516.9	21.51	
Average Weekly.			00	149.3	86.1	3.58	3.57

TABLE IX.

BESSIE GENEVA 2d—FED SUGAR BEETS.

Week.	Weight of Cow.			Beets Eaten.	Milk.	Butter.	Percent Fat.
	Beginning	End.	Gain.				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
8th and 9th	1290	1260	—30	168	519.7	28.16	4.59
Total.							
Average Weekly.			—15	84	259.8	14.08	4.59

TABLE X.

BESSIE GENEVA 2d—FED BEET PULP.

Week.	Weight of Cow.			Pulp Eaten.	Milk.	Butter.	Percent Fat.
	Beginning	End.	Gain.				
10th and 11th	1260	1220	—40	336	557.2	27.23	3.91
Total.							
Average Weekly.			—20	168	278.6	13.61	3.91

TABLE XI.

FIVE COWS ON BEETS.—NINTH WEEK.

Cow.	Weight.			Beets Eaten.	Milk.	Butter.	Percent Fat.
	Beginning	End.	Gain.				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Brindle No. 3.	850	860	10	84	210.7	9.78	3.96
Black Cow.	990	1030	40	84	255.5	12.86	4.38
Red Cow.	880	890	10	84	180.5	8.78	4.11
Brindle.	1030	1040	10	84	234.2	12.68	4.12
Old Spot.	860	870	10	84	170.7	8.10	4.01
Total.			80	420	1051.6	52.20	
Average Weekly Per Cow.			16	84	210.3	10.44	4.12

TABLE XII.

FIVE COWS ON PULP.—TENTH AND ELEVENTH WEEKS.

Cow.	Weight.			Pulp Eaten.	Milk.	Butter.	Percent Fat.
	Beginning	End.	Gain.				
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Brindle No. 3.	860	800	—60	336	465.5	20.00	3.70
Black Cow.	1030	990	—40	336	529.0	23.33	3.75
Red Cow.	890			336	376.5	19.13	4.18
Brindle.	1040	935	—105	336	470.7	24.04	4.24
Old Spot.	870	820	—50	336	396.0	18.33	3.95
Total.			—255	1680	2237.7	104.83	
Average Weekly Per Cow.			—32	168	223.8	10.48	3.96

DAINTY NOBLE.—TABLES I AND II.

Dainty Noble is a registered Jersey heifer. At the time of this experiment she was in her first period of lactation, her calf having been dropped January 1, 1902, at which time Dainty Noble was twenty-one months old. Her calf was taken away immediately after birth. Dainty Noble was fed liberally with a ration of wheat and corn chop and alfalfa hay. Sugar beets also formed a part of the ration most of the time until the experiment began, so the beets were not altogether a new food for her, and there would be no undesirable results from change of food ration.

GILDANA.—TABLES III AND IV.

Gildana is an old decrepit Jersey having passed the useful years of her life and is being kept as a nurse cow for unfortunate calves from our beef herds. Gildana's last calf was dropped in August, 1901, from which time she had been milked as her motherly services had not been required elsewhere. She too had been fed sugar beets along with a grain and alfalfa ration. The largest milk record which Gildana leaves is from January 1, 1897, to January 1, 1898, during which time she produced 7,809 pounds of milk. The per cent of butter fat is not recorded.

YOUNG GRANNIE.—TABLES V AND VI.

Young Grannie had dropped her sixth calf in August, 1901, being herself eleven years old the previous May. In her prime she had been a good milker and a large profit cow. Young Grannie is also a registered Jersey. The ration of sugar beets, wheat and corn chop and alfalfa hay had also been fed to Young Grannie.

MOUNTAIN BEAUTY.—TABLES VII AND VIII.

Mountain Beauty is a pure-bred Shorthorn heifer out of Bessie Geneva 2d. As a calf Mountain Beauty was of remarkable proportions. "She is as handsome a calf as I ever saw" were the words of the President of the National Live Stock Association. Mountain Beauty dropped her first calf when she was still very young. It was thought advisable to take the calf away from her, and in despite of the high condition in which she had been kept for the fairs, to see if she would still show the tendency of her dam in the dairy line.

Mountain Beauty had not been accustomed to sugar beets before the experiment as had the preceeding cows.

BESSIE GENEVA 2d.—TABLES IX AND X.

Bessie Geneva 2d dropped her fourth calf April 9, 1902, when she was five years and eight months of age. As soon as her milk was good to use she was put on the experiment, which was in time to give her two weeks each on beets and pulp. This was the second year that she had been milked. Previous to that time her calves had been allowed to take the milk.

Sugar beets had been a part of the ration fed to Bessie Geneva 2d during the winter months of 1901–02.

FIVE COWS IN TABLES XI AND XII.

The five cows reported in these tables were scrub cows purchased to furnish milk to the College dairy. They had calved from two weeks to two months previous to the time they were brought to the College farm. None of them had been given grain or had received anything but pasture grass. When we obtained possession of them they were weighed up and put upon the experiment at once and given the same ration of grain, alfalfa, sugar beets and pulp as were the other cows. These cows are not considered in the results because they were not on the experiment long enough to give an intelligent idea of the effect of the beets and pulp.

It will be noticed in Table XII that four cows made a total loss, during the two weeks that they were fed pulp, of 255 pounds. This is probably explained by the fact that a little more than one week before this time, these cows came directly off of pasture and were put on a grain ration. It would be natural then for them to fill up for some time and apparently gain flesh during the first week on sugar beets, and then apparently lose weight rapidly during the two following weeks. For this reason the results of these cows are not used in computing the comparative cost and profits.

The results for the first five cows which were on feed long enough to make the comparison of sugar beets and pulp of some value, show that the two foods gave almost identical returns. The pulp ration gave slightly better returns when fed to Dainty Noble and Young Grannie. Bessie Geneva 2d gave more milk but not quite so much butter per week when on pulp, and also lost most flesh. The beets apparently gave better returns with Gildana and Mountain Beauty. The per cent fat in the milk varies so much that it is difficult to draw definite conclusions in regard to which ration produced the richest milk. Our averages show a little more milk from the pulp ration and a little higher fat content in milk from the beet ration.

TABLE XIII.

COST AND PROFIT—FROM FEEDING BEETS AND PULP.

AVERAGE WEEKLY.

Cow.	Food.	Cost of Food per Week.			Value Butter @ 20 cts per lb.	Value Gain @ 5 cts. per lb.	Profit from Butter.	Value Milk @ 1 ct per lb.	Profit from Milk.
		Beets.	Pulp.	Total.					
	Beets	cts. 15.7	cts.	$ 1.07	$ 1.40	$ 0.10	$ 0.43	$ 1.21	$ 0.24
Dainty Noble	Pulp.		7.47	1.00	1.41	0.58	0.99	1.23	0.81
	Beets.	15.7		1.07	0.77	0.21	—0.09	0.67	—0.49
Gildana	Pulp.		7.0	0.99	0.73	0.23	—0.03	0.64	—0.12
	Beets.	14.9		1.05	1.19	—0.33	—0.19	1.00	—0.38
Young Grannie	Pulp.		6.55	0.99	1.18	0.96	1.15	1.02	0.99
	Beets.	16.8		1.09	0.74	0.37	0.02	0.88	0.16
Mountain Beauty	Pulp.		7.46	1.00	0.72	0.00	—0.28	0.86	—0.14
	Beets.	16.8		1.09	2.82	—0.75	0.98	2.60	0.76
Bessie Geneva 2d	Pulp.		8.40	1.01	2.72	—1.00	0.71	2.79	0.78

Table XIII gives the cost of beets eaten, pulp eaten and total cost of all the food for each week, and the values of gain and products with the corresponding profit weekly for each of the five cows which were fed the longest. The cost of the beets eaten is computed from a value of $4.00 per ton on the farm, beet pulp $1.00 per ton, alfalfa $4.00 per ton, wheat chop $1.00 per hundred pounds, and corn chop $1.30 per hundred. The gain or loss in weight of the cows is valued at five cents per pound, and the butter made at 20 cents per pound to give the profit from butter. The amount of butter yield is computed from the amount of fat by increasing the total fat by 16.6 per cent. The profit from the milk production is also given and was computed in the same way, valuing the milk at one cent per pound.

Dainty Noble, on beets, gave a profit of 43 cents per week from the butter, or 24 cents per week from the milk yield. On pulp she gave a profit of 99 cents per week on butter, or 81 cents on milk.

Gildana, when fed beets, gave a loss of 9 cents from butter yield, or of 49 cents from milk yield. On pulp she gave a loss of 3 cents per week from the butter yield, or 12 cents per week from the milk yield.

Young Grannie, when fed beets, gave a loss of 19 cents per week from butter yield, or 38 cents per week from milk yield. On pulp she gave a profit of $1.15 per week from butter yield, which is the highest profit from any of the cows. Her profit is 99 cents per week from milk yield.

Mountain Beauty, when fed beets, gave a profit of 2 cents per week from butter yield, or 16 cents per week from yield of milk. When fed on pulp she gave a loss of 28 cents per week on butter yield, and 14 cents per week from yield of milk.

Bessie Geneva 2d, when fed on beets, gave a profit of 98 cents per week from butter yield, or 76 cents from her milk yield. On pulp she gave a profit of 71 cents in butter or 78 cents in milk.

The difference between the profit and losses made by all the cows while fed beets shows a total profit of 81 cents, against a total profit on pulp of $2.54. Accrediting all of the profit to the total pulp fed gives the pulp a value of $2.61 per ton, and in like manner attributing the profit made by cows on beet ration to the amount of beets which they consumed gives the beets a feeding value of $5.06 per ton.

SUMMARY.

Five cows fed 24 pounds of beet pulp for six weeks, in addition to grain and hay, made an average gain per week of 6.2 pounds. The same cows fed 12 pounds of beets per day for five weeks made an average gain per week of one-fifth pound.

Five cows on the pulp ration gave an average weekly milk yield of 131.1 pounds, and on the beet ration they gave an average weekly milk yield of 127.4 pounds.

Five cows on the pulp ration gave an average weekly butter yield of 6.76 pounds, and on the beet ration an average weekly butter yield of 6.90 pounds. The milk contained a little more butter fat when the cows were fed sugar beets.

A little more than three times as much profit resulted from feeding 24 pounds of pulp per day than was realized from 12 pounds of beets per day, at one dollar and four dollars per ton respectively.

The total profits indicated a feeding value of the pulp for butter production of $2.61 per ton, and of the beets of $5.06 per ton when fed in small amounts, and when butter is worth 20 cents per pound.