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# Soybeans for Dairy Cows

T.M. Olson

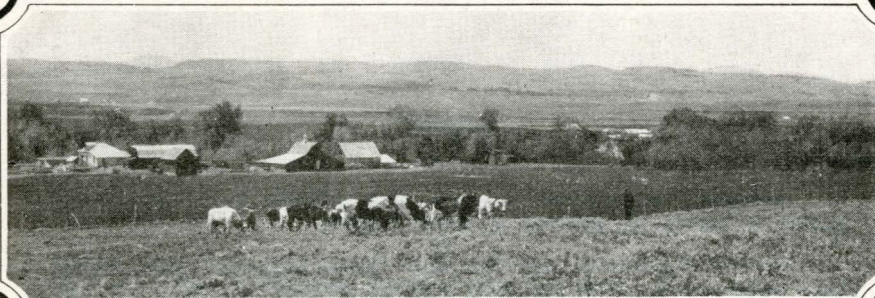
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# Soybeans *for* Dairy Cows

**DAIRY DEPARTMENT**  
**Agricultural Experiment Station**  
OF THE  
**South Dakota State College of**  
**Agriculture and Mechanic Arts**



## *Digest*

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Soybeans and soybean hay are high protein feeds, and can be grown in nearly all sections of South Dakota.

Several experiment stations have found soybeans and soybean hays equal to or better for milk and fat production than such high protein feeds as cottonseed meal and old process linseed oil meal, and such protein roughages as alfalfa hay.

The object of the investigations at South Dakota State College was to determine the feeding value of ground soybeans and soybean hay and to note if the ground soybeans had any deleterious effects on the butter.

Three 30-day trials were conducted—two trials in which ground soybeans were compared to old process linseed oilmeal, and one trial in which soybean hay was compared with alfalfa hay. Four cows were used in each trial.

To ascertain the effect of ground soybeans on butter, varying amounts of ground soybeans were added to the ration, beginning with 15 percent by weight and increasing the ground soybeans to a ration of 100 percent ground soybeans.

The ground soybeans were as palatable, and seemed to have as desirable physiological effect on the cows as linseed oilmeal.

Ground soybeans proved to be 20 percent more valuable for milk production and 18 percent more valuable for fat production than oilmeal.

Soybean hay, according to the experiment, is 6 percent more valuable for milk production and 8 percent more valuable for fat production than alfalfa hay.

The results indicate that ground soybeans can be fed with profit by dairy farmers for the high protein feed, and thus decrease the cost of milk production materially.

Soybean hay is not as cheap a legume roughage in South Dakota as alfalfa hay because of the comparatively lower yield and expense in handling; however, soybean hay can be recommended as an emergency legume crop for dairy cows and as a regular crop in regions where alfalfa or other clovers are hard to get started.

Ground soybeans have no deleterious effect on butter when fed in reasonable amounts; neither can soybeans be depended on to influence the percent of fat in milk for any appreciable length of time.

# Soybeans for Dairy Cows

THOMAS M. OLSON\*

**E**FFICIENCY is the watchword of success in all industries, including dairying. The dairyman who produces milk at a lower cost per unit than his competitors will of course make greater net profits. There are many phases of the dairy industry in which greater efficiency can be practiced with good results, but none more important than feeding. Feeds represent from two-third to three-fourths the costs in producing milk; hence greater efficiency in this phase of dairying will result in greater profits.

That it is poor economy to underfeed good dairy cows has been proved experimentally and under practical feeding conditions; hence for best results, dairy cows must be provided with those feeds in sufficient quantity which are required for most economical production.

Feeds high in protein are essential to high as well as economical production. High protein feeds also command the highest price on the market. Therefore, when these high protein feeds are home grown, their cost is materially lower than the market value of feeds correspondingly high in protein. The lower cost will frequently lead to more liberal feeding.

Only one home grown high-protein feed, soybeans, will be considered in this bulletin, and the data will deal only with its feeding value.

In recent years, the soybean as a forage crop, soil improver, and as a high protein feed, has received considerable attention. The soybean plant in its seed provides more protein per acre than does any other seed-bearing legume plant which grows in the temperate zone. With the number of varieties now available, soybeans can be grown in most sections of the country; hence their importance as a high protein feed for dairy cows deserves attention by all dairy farmers.

## Resume of Previous Work

The relative value of ground soybeans and cottonseed meal for milk production was tested by Price at the Tennessee Station (1) with two lots each of two, three, and four-year-old heifers. The following rations were fed alternately during three thirty-day periods:

1. Ground soybeans, 2.3 pounds; corn silage, 24.7 pounds; corn, 2.3 pounds; cob meal, 10.3 pounds; alfalfa.
2. Cottonseed meal, 2.3 pounds; corn silage, 23.5 pounds; corn 2.3 pounds; cob meal, 10.0 pounds; alfalfa hay.

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\*This bulletin includes data obtained from experimental work performed by John R. Bollinger and Willard R. Beall in partial fulfillment of work for their M. S. degree, under the direction of the author. Acknowledgment is also made of the helpful services of C. F. Wells, chemist, who had charge of the analytical work and of John Nelson, who cared for the cows on experiment.



Daily production of milk and butterfat on these two rations was as follows:

	Milk lbs.	Butterfat lbs.
1. On soybean ration .....	14.4	0.81
2. On cottonseed .....	13.6	0.77

This trial shows an increase of 0.8 pounds of milk and 0.04 pounds of fat in favor of the soybean ration.

At the Massachusetts Station (2), two lots of four cows each were fed six weeks by the reversal method. To a basal ration of hay, silage, and bran, an allowance of either ground soybeans or cottonseed meal was added in practically equal amounts. The ground soybeans proved slightly superior to the cottonseed meal as a milk and fat producer and the butter was of better quality.

Cook of the New Jersey Station (3) found 3 4 pounds of ground soybeans slightly superior to the same weight of cottonseed meal when fed with 3.4 pounds of corn and cob meal and 2.3 pounds of dried beet pulp, with silage, soilage, and hay for roughage.

Gilchrist of Armstrong College, England (4), found soybean cake slightly superior to cottonseed cake for milk production. Six cows were fed for six weeks on each protein supplement. The basal ration consisted of hay, oat straw, crushed oats and roots.

Hansen of the Royal Agricultural Academy, Germany (5), found soybean cake and linseed cake practically equal in feed value for milk production when added to a basal ration of hay, bran and sugar beet chips. No ill effects resulted, although 4 to 7 pounds of soybean cake were fed daily. The average yield per cow per day during two periods of 14 days each, was:

	Milk lbs.	Percent fat
Linseed cake .....	28.9	3.45
Soybean cake .....	29.8	3.33

The results of two trials at the Iowa Experiment Station (6) when the cows were fed with a basal ration of corn, silage, alfalfa hay and a grain mixture of equal parts of cracked corn and ground oats, indicated that 611 pounds of oil meal produced 3,483.3 pounds of milk and 149.75 pounds of fat; 591 pounds of soybeans produced 3,345.0 pounds of milk and 160.94 pounds of butterfat. The amount eaten of the basal ration was practically the same in both trials. The report states that according to these data, the value of soybeans may be placed at \$60.00 per ton when oilmeal is worth \$45.00 per ton.

In two trials at the West Virginia Station (7), soybean hay was compared with alfalfa hay for milk production. Ten pounds of alfalfa or soybean hay were fed each animal daily. Lot I produced 2,685 pounds of milk and 102 pounds of butterfat on the soybean hay. Lot II produced 3,015 pounds of milk and 106 pounds of butterfat when soybean hay was fed, and 2,888 pounds of milk and 106 pounds of butterfat on the alfalfa hay. Lot I gained an average of 12 pounds live weight on alfalfa hay, and 85 pounds on soy-

bean hay, whereas lot II lost 95 pounds on soybean hay and 17 pounds on alfalfa hay.

The results of the two experiments indicated that soybean hay was superior to alfalfa hay for milk and fat production and maintenance of weight. The milk production was 64 pounds greater, and the fat production 5 pounds greater for all animals in all trials in favor of the soybean hay. The net gain in live weight for all cows in all trials was 150 pounds during the soybean periods, and a loss of 22 pounds during the alfalfa periods.

### **Purpose of Experiment**

Soybeans are grown in most sections of South Dakota. Varieties can be grown which are adapted for forage or seed, and information concerning their feeding value is important. With this in view, the Dairy Department conducted two feeding trials on ground soybeans and one on soybean hay to determine their feed value for dairy cows, and to note whether the ground soybeans have any deleterious effect on the butter.

In conducting the experiment, the alternate method was used. Four cows were used for each trial. They were kept in ordinary stalls so constructed that each animal could be fed separately. A small metal tank was placed between two mangers in which water was kept before the cows at all times.

The experimental trials were divided into 40-day periods. The first ten days of each period were taken as the transition period. These data are not considered in this bulletin. The 30-day periods were further subdivided into 10-day periods.

The data included in this bulletin represent nine 30-day periods conducted in three years. Six periods were trials during which ground soybeans were compared with oil meals, and three were trials for comparing alfalfa hay with soybean hay.

Twelve cows were used. One grade Guernsey, Number 157, was used in two different trials. Cows chosen for each trial were as uniform in lactation, gestation and general condition as were available. The four major breeds were represented, and the cows used were considerably above the average in production. Three of the cows used in the trials were among the highest producers in the College herd, and have creditable official records.

The cows were hand milked twice a day. The same person did the milking throughout the trial except for a few brief periods. The cows were allowed to exercise in a dry lot on nice days. They did not get as much exercise as the cows in the general herd, but sufficient so that this should not be a factor in influencing the results. The cows were curried twice a day. Salt and water were kept before them at all times. They were weighed regularly and the average of three successive weighings taken as the average weight. Ten-day composite milk samples were taken during the entire time of each experiment.

The Morrison Feeding Standard was used in balancing the rations, which were changed as often as milk production and body

weight made it necessary. The cows were fed twice a day. The alfalfa hay, soybean hay and silage were grown on the college farm, while the corn and oats were grown on farms near by. The oilmeal and soybeans were purchased from the local elevator. The soybeans were grown in South Dakota. All grains were ground, including the soybeans. The alfalfa and soybean hays were fed without cutting. The grain mixture for each cow was fed on the silage in a feed box and the alfalfa and soybean hays were fed in a tight manger. All feeds refused by the cows were weighed back and analyzed.

All grains used were of good quality except the corn in the last trial. This was of poor quality, being very low in ether extract. The soybean hay was not as good quality as the alfalfa, having in it considerable weeds, as well as being coarser than is desired for good forage.

### Digestion Trials

Two digestion trials were conducted during each experiment. The trials were during the last five days of the second and third periods of each experiment. A careful record was kept of all feed eaten and refused during the five-day periods. Chemical analyses were made of all feeds as well as feces.

The feces were collected by a man in constant attendance and placed in galvanized iron cans fitted with tight covers. At the end of the experimental day, the collections of excreta were weighed and sampled. The feces were mixed thoroughly in a galvanized iron tub and an aliquot portion taken. These samples were taken immediately to the chemistry laboratory.

### Palatability and Physiological Effects

The palatability is an important factor in determining the value of any feed, because consumption so largely depends on it. Both the ground soybeans and the soybean hay were readily eaten. At no time did the animals refuse to eat the ground soybeans even when the soybeans made up 100 percent by weight of the grain ration. The soybean hay was also readily eaten, although the coarser parts of the plants were left in the mangers. The soybean hay, however, was not as good quality as the alfalfa hay with which it was compared. The plants were too large and coarse and had some weeds mixed in with them.

Judging from the gloss of the coat and general appearance of the cows during the various trials, there seemed to be no physiological difference between ground soybean and old-process oilmeal. During the feeding of the soybeans, the cows gave indication of being in the best physical condition. Soybeans did not seem to have as marked a laxative effect as oilmeal, although the feces during the heavy feeding of the ground soybeans was softer than during the light feeding, indicating that it does have a slight laxative effect.

The cows were in good physical condition during both the soybean hay and alfalfa hay periods. The periods were too short and the amount of roughage fed too limited to draw any conclusions as to the physiological effects of the two feeds; however, no differences

were observed. Table I seems to indicate no effects on the weight from the various feeds.

TABLE I—AVERAGE WEIGHT BY 30-DAY PERIODS

No. of Cow	Oilmeal Period lbs.	Soybean Period lbs.	Oilmeal Period lbs.	Alfalfa Period lbs.	Soybean Hay Period lbs.	Alfalfa Hay Period lbs.
157 ...	1099	1140	1168	.....	.....	.....
75 ...	1094	1112	1152	.....	.....	.....
23 ...	1410	1420	1436	.....	.....	.....
20 ...	1722	1756	1818	.....	.....	.....
82 .....	.....	.....	.....	956	992	1048
258 .....	.....	.....	.....	1084	1109	1140
306 .....	.....	.....	.....	1237	1289	1293
209 .....	.....	.....	.....	1118	1137	1161
151 ...	1000	1024	1048	.....	.....	.....
152 ...	1238	1282	1331	.....	.....	.....
157 ...	1215	1200	1212	.....	.....	.....
211 ...	891	*876	902	.....	.....	.....

\*The loss of weight in cow number 211 is due to her going off feed for several days in the second period.

TABLE II—ANALYSIS OF FEEDS

Oilmeal Period				
	Protein	N. F. E.	Ether Ext.	Cr. Fiber
Alfalfa Hay .....	14.44	38.67	1.34	31.87
Corn Silage .....	1.79	12.32	.45	5.24
Grain Mixture .....	18.125	58.90	3.10	7.63
Soybean Period				
Alfalfa Hay .....	16.01	43.20	1.41	24.74
Corn Silage .....	1.77	11.74	.42	4.67
Corn .....	9.19	68.32	1.28	2.45
Oats .....	10.12	60.44	3.95	12.58
Soybeans .....	33.25	28.53	16.10	7.72

TABLE III—TOTAL NUTRIENTS IN FEEDS

Average of Oilmeal Period					
	Protein	N. F. E.	Ether Ext.	Cr. Fiber	Total Nut.
Alfalfa Hay .....	203.45	544.86	18.88	449.04	2677.2
Corn Silage .....	69.81	480.48	17.55	204.36	
Grain Mixture .....	127.23	413.47	21.76	53.56	
	400.49	1438.81	58.19	706.96	
Soybean Period					
Alfalfa Hay .....	192.44	519.26	16.94	297.37	2448.5
Corn Silage .....	69.03	457.86	16.38	182.13	
Corn .....	22.05	163.96	3.07	5.88	
Oats .....	25.80	154.12	10.07	32.07	
Soybeans .....	69.82	59.91	33.81	16.21	
	379.14	1355.11	80.27	533.66	



TABLE IV. TOTAL POUNDS OF FEED CONSUMED IN ALL TRIALS

	Oil Meal vs. Ground Soybean						Alfalfa vs. Soybean Hay	
	First Trial		Second Trial		Average		Alfalfa	Soybean Hay
	Oil-meal	Soy-beans	Oil-meal	Soy-beans	Oil-meal	Soy-beans		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Alfalfa Hay	1952.0	1932.0	1409.0	1202.0	1680.5	1567.0	1307.5	.....
Corn Silage	4281.0	4360.0	3900.0	3900.0	4090.0	4130.0	3266.0	3286.8
Corn	677.0	694.0	239.0	240.0	483.0	467.0	561.7	570.0
Oats	590.0	555.0	254.0	255.0	422.0	405.0	477.0	480.0
Oil Meal	263.3	.....	209.0	.....	237.6	.....	109.2	120.0
Soybeans	.....	210.5	.....	210.0	.....	210.0	.....	.....
Soybean Hay	.....	.....	.....	.....	.....	.....	.....	1212.6
Tot. Nutrients	3761.0	3768.0	2677.2	2448.5	3219.05	3108.2	2918.9	3019.9
Lbs. of Milk	3693.4	3788.2	1967.8	2115.5	2830.6	2951.9	2706.5	2678.1
Lbs. Fat	135.77	135.78	101.57	104.88	118.67	120.33	132.29	133.3

TABLE V—NUTRIENTS DIGESTED IN ALL TRIALS

	Oil-meal	Soy-beans	Oil-meal	Soy-beans	Oil-meal	Soy-beans	Alfalfa	Soybean Hay
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Protein	361.6	386.8	256.7	258.2	309.1	322.5	319.3	190.1
N. F. E.	1531.6	1704.4	1179.9	1164.0	1355.7	1434.1	1419.7	1460.1
Ether Extract	81.4	103.5	45.8	67.9	63.6	85.7	68.1	80.1
Crude Fiber	452.4	634.3	467.9	340.5	460.1	487.4	389.9	497.5
Tot. Dig. Nut.	2528.7	2958.3	2007.5	1915.5	2268.0	2436.9	2282.1	2327.9

### General Discussion

A study of Tables II and III will aid in understanding the discussion which follows. Table II shows the analysis of the feeds used. Note that the ether extract of the corn is considerably below the average for even immature corn. This same lot of corn was used for the grain mixture, which accounts for the relatively low analysis in ether extract in the mixture also. Table III contains the total nutrients in all feeds consumed for the three 30-day trials.

Table IV contains the pounds of feed and total nutrients for all trials of the experiment. It also shows the total pounds of milk and fat produced during the respective periods. Table V shows the nutrients digested from each feed and also the total digestible nutrients for all trials.

It will be noted that the total digestible nutrients are relatively higher for all nutrients during the first soybean period. No reason is offered for this fact. The total digestible nutrients were somewhat higher in the soybean hay than in the alfalfa hay. This was largely due to the larger amount of crude fiber digested in the case of the soybeans.

Tables VI and VII contain the total milk and fat production for the 30-day periods. Figures 1 and 2 have the same data in a graphical form.

### Comparative Feed Value

The table of the total feed consumption indicates that the total nutrients consumed were approximately the same. However, when applying the coefficients of digestion, which were somewhat higher in the first soybean period, we find that more nutrients were consumed in the soybean period. The lower coefficient in case of protein for the soybean hay is probably due to the poor quality of hay used.

The practical feeder, however, is more concerned with the results obtained from total feed fed. Studying the data from that point of view, the nutrients in 210 pounds of ground soybeans produced 2951.8 pounds of milk, while the total nutrients in 237.6 pounds of oilmeal produced 2830.6 pounds of milk. On the basis of fat production, 210 pounds of ground soybeans produced 120.33 pounds of fat, and 237.6 pounds of oilmeal produced 118.67 pounds of fat.

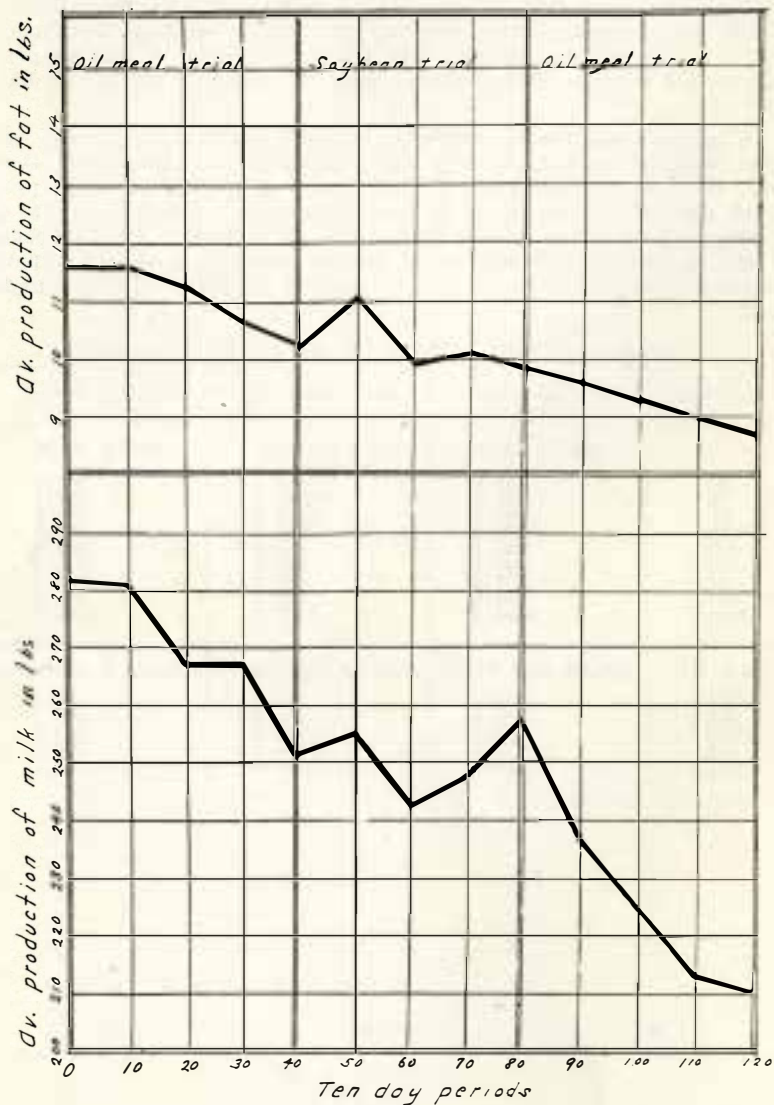
TABLE VI—MILK PRODUCTION BY 30-DAY PERIODS

Cow No.	Oilmeal Period	Soybean Period	Oilmeal Period
	lbs. of milk	lbs. of milk	lbs. of milk
157	589.6	594.5	547.1
75	805.8	744.9	616.3
23	1428.7	1196.1	1037.6
20	1388.5	1252.7	973.0
157	427.2	416.3	372.4
151	409.1	423.2	414.3
152	667.0	690.2	640.9
211	483.5	535.3	521.3
Total	6199.5	5993.7	5122.6

Cow No.	Alfalfa Hay Period	Soybean Hay Period	Alfalfa Hay Period
82	716.6	697.7	587.7
209	730.0	674.2	687.4
258	537.5	537.5	558.8
306	823.3	768.2	770.6
Total	2807.4	2677.6	2604.5

*The general trend of milk and fat production  
average of eight cows.*



**Fig. 1.—Oilmeal vs. ground soybeans for milk and fat production**

TABLE VII—FAT PRODUCTION BY 30-DAY PERIODS

Cow No.	Oilmeal Period	Soybean Period	Oilmeal Period
	lbs. of fat	lbs. of fat	lbs. of fat
157	30.74	32.11	33.36
75	40.00	35.50	20.71
23	39.27	33.08	28.68
20	39.85	35.09	29.93
157	32.88	30.24	26.92
151	27.12	25.39	24.58
152	22.45	23.32	22.20
211	25.05	25.33	21.85
Total	257.36	240.66	207.33

Cow No.	Alfalfa Hay Period	Soybean Hay Period	Alfalfa Hay Period
82	45.4030	45.6515	40.1201
209	28.7985	27.5687	28.6421
258	30.9048	31.9793	33.8742
306	28.6569	28.1638	28.5042
Total	133.76	133.36	131.14

The data of this experiment indicate that 97 pounds of ground soybean are equivalent to 121 pounds of old process oilmeal for milk production and that 116 pounds of soybean hay are equivalent to 123 pounds of alfalfa hay for milk production. On a basis of money value, ground soybeans are worth 20 percent more for milk production and 18 percent more for fat production than oilmeal. Soybean hay is 6 percent more valuable for milk production and 8 percent more valuable for fat production than alfalfa hay.

It is not the function of this bulletin to discuss the method of growing soybeans nor the variety to grow, but merely to indicate that soybeans are a very valuable high protein feed, and can be grown by dairy farmers for that purpose with profit.

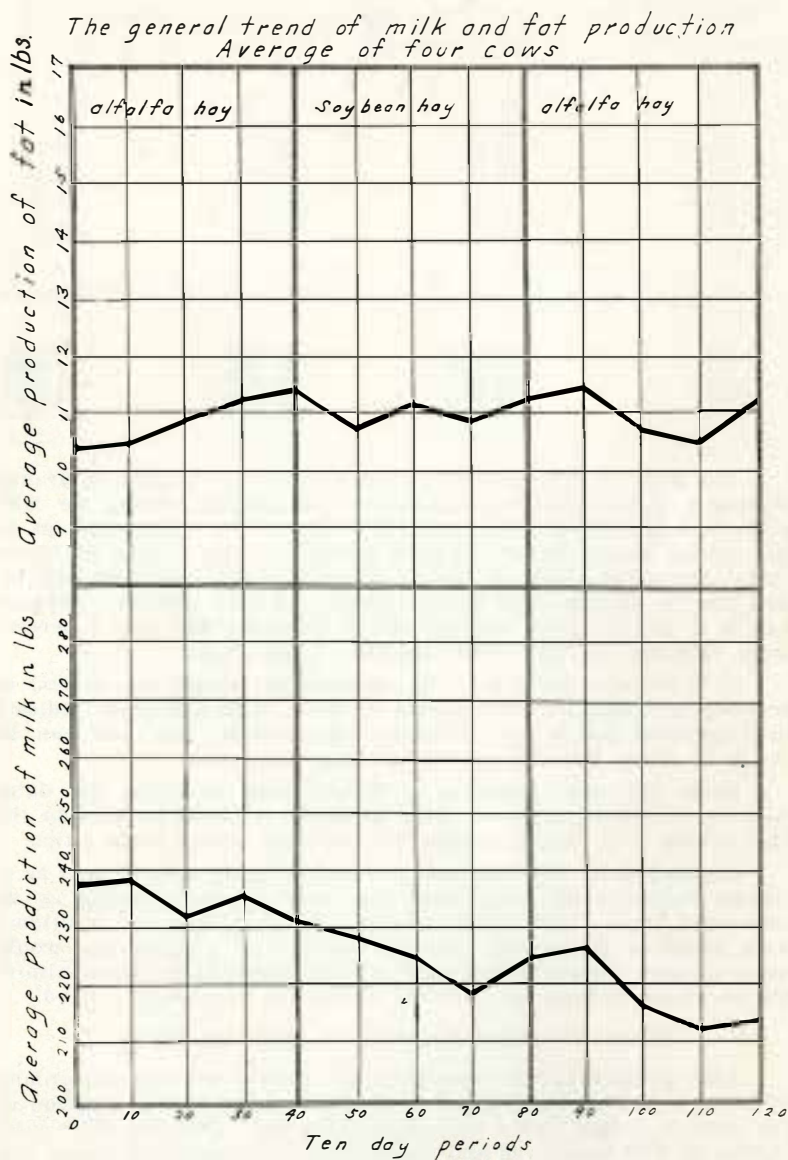
From the data obtained, it would seem advisable for dairy farmers in South Dakota to grow sufficient soybeans to provide the high protein feed used to supplement the home grown grain ration.

Soybean hay, although about equal to good alfalfa hay as a legume roughage for dairy cows, can only be recommended as an emergency crop. The comparatively low yield and the additional work required in growing and harvesting the soybean hay would make it more expensive feed than alfalfa, particularly where alfalfa can be grown without too great an initial cost in getting a stand.

#### Effect of Ground Soybeans on Milk and Butter

After completing the experiment, the same cows were fed ground soybeans in increasing amounts in their rations, allowing a period of five days to elapse before collecting the milk. The fifth day's production of milk was saved and separated and the resulting cream was churned in a small hand churn. Five-day composite samples were taken to note any effect which the ground soybeans might have on the percent of fat in the milk.





**Fig. 2.—Alfalfa hay vs. soybean hay for milk and fat production**

A group of seven cows of the regular herd, which were receiving our regular test ration, were also fed 4 pounds of ground soybeans per day in addition to their regular ration for two successive days. The additional feed was readily eaten with no apparent bad effects. Table VIII shows the average test of the five-day composite samples before adding the soybeans, and after the addition of 4 pounds of soybeans daily for two days.

TABLE VIII—INFLUENCE OF GROUND SOYBEANS ON PCT. OF FAT

Herd No. ....	320	336	337	24	338	333
	Percent	Percent	Percent	Percent	Percent	Percent
Before adding soybeans	2.95	3.60	3.50	3.30	2.95	2.90
After adding soybeans	3.20	3.20	3.25	3.15	3.40	3.15

Table IX shows the daily average production of milk, and percent of fat of the four cows which were fed increasing amounts of the ground soybeans beginning with 14 percent of the grain ration by weight and increasing to a 100 percent soybean ration.

TABLE IX—VARYING AMOUNTS OF GROUND SOYBEANS IN RATION

Cow No. ....	151			152			157			211		
Percent of Soybean in Ration	Lbs. milk 5 days	Pct. fat		Lbs. milk 5 days	Pct. fat		Lbs. milk 5 days	Pct. fat		Lbs. milk 5 days	Pct. fat	
15	69.7	5.70	104.6	3.50	60.3	6.95	78.9	4.20				
25	74.4	5.85	104.2	3.55	59.7	7.05	86.1	4.20				
50	75.0	5.75	101.2	3.95	60.1	7.15	86.3	4.35				
75	70.2	5.70	94.2	4.10	59.3	7.10	90.3	4.50				
100	67.2	6.10	87.9	4.40	64.1	7.20	89.5	5.00				

From the data in Tables VIII and IX, it would seem that ground soybeans do increase temporarily the percent of fat in milk with some cows. However, one would have to know the reaction of the individual cow to make certain of the results. It is also a question of how long these same cows would respond with an increased test on the ground soybeans, and also whether they would respond in the same manner a number of times. This problem is being tested on the four cows, but none of the data is included in this bulletin. The table also shows the total milk for the five-day periods. The variation in the amount of milk is not significant.

#### Effects of Ground Soybeans on Butter

So far as the deleterious effects of ground soybeans on butter are concerned, it is of little consequence. The data indicate that at least 50 percent by weight of the ration must be made up of soybeans before any appreciable softness in the butter can be detected; and even where 75 and 100 percent of the ration is made up of ground soybeans, the effect on the butter was not apparent unless on close inspection.

Practical feeding conditions would practically eliminate the deleterious effects of ground soybeans if there were any, because it would not be practical or advisable from the standpoint of economy or welfare of the animal to feed such a large quantity of soybeans that the product would be affected.

Table X indicates the results of the chemical analysis of butter from soybean rations made up of the percentages indicated in Table IX.

TABLE X—CHEMICAL ANALYSIS OF BUTTER

		Iodine No.	Sap. No.	Melting Point	Refractive Index at 25°C
Control	Samples	33.02	227.5	33.2C	1.4600
14	Pct. soybean ration	34.30	237.0	31.0	1.4545
25	Pct. soybean ration	34.50	224.7	32.8	1.4604
50	Pct. soybean ration	36.30	224.1	32.5	1.4606
75	Pct. soybean ration	38.04	223.7	32.35	1.4608
100	Pct. soybean ration	41.00	221.8	32.10	1.4610

These data indicate that butter from the ground soybean ration does have a higher iodine number and shows a higher unsaturated fatty acid content. The difference in melting point is very slight. No effects could be noted in odor and flavor of milk and cream from the soybean ration.

Lindsey at the Massachusetts Station reported that the iodine number increased to 40, that the saponification number was reduced about ten points, and that little or no change occurred in the melting point of the butter when one-half to one pound of soybean oil was fed daily per head. In a later report, Lindsey (2) showed that the soybean meal, partially extracted, feeding 2.3 pounds per day per head, seemed to be without influence in changing the proportions of the several milk constituents or imparting flavor to milk. Expert butter scorers could not detect any particular flavor in the butter as a result of feeding the meal. The meal gave a noticeable softness to the body of the butter, but not sufficient to injure its commercial value. He attributed the softness to the oil in the soybean rather than to the protein.

It is possible that if soybeans were fed in large amounts for long periods, that the butter would be noticeably softer; but as previously pointed out, this is not likely to occur under practical feeding conditions.

TABLE XI—SUMMARY OF DATA

	Av. of Periods		Av. of Period	
	Oil-meal Lbs.	Soy-bean Lbs.	Hay Alfalfa Lbs.	Hay Soy-bean Lbs.
On basis of average of one cow				
Av. milk production for 30-day period.....	707.7	738.0	676.1	669.5
Av. fat production for 30-day period.....	29.67	30.08	33.07	33.32
Av. lbs. of feed consumed in 30-day period.....	59.41	52.56	326.9	303.15
Av. lbs. of nutrients consumed in 30-day period.....	804.8	777.1	729.7	754.97
Nutrients furnished by feeds compared.....	56.05	57.3	285.6	294.9
Lbs. of feed to produce 100 lbs. milk.....	120.6	96.6	123.4	115.9
Lbs. of feed to produce 1 lb. fat.....	28.77	23.68	25.25	23.28

### Conclusions

1.—Ground soybeans when fed with the basal ration were 17.7 percent more efficient than old process linseed oilmeal for fat production and 19.9 percent more efficient for milk production.

2.—Ground soybeans apparently were as palatable and gave as good physiological results as old process linseed oilmeal.

3.—The ground soybean rations were readily eaten even when 100 percent of the grain ration was composed of soybeans.

4.—Ground soybeans, in the first trial, when fed with the same basal ration as oilmeal, had a higher coefficient of digestibility for all nutrients.

5.—The data of this experiment indicate that soybean hay is 6 percent more efficient for milk production and 7.8 percent more efficient for fat production than good quality alfalfa hay.

6.—When oilmeal is selling for \$60.00 per ton, ground soybeans are worth \$72.00 per ton for dairy cows.

7.—Ground soybeans do not noticeably affect the consistency of the butter until the grain ration contains 50 percent or more of ground soybeans.

8.—Ground soybeans seem to influence the percent of fat in milk with some cows at least temporarily but not its flavor or odor.

9.—Soybean hay is not as cheap a legume roughage in South Dakota as alfalfa hay for dairy cows because of the comparatively lower yield, and expense in handling the soybean hay.

10.—Soybean hay can be recommended as an emergency legume crop for dairy cows, and as a regular crop in sections where it is difficult to get a stand of clovers.

11.—Greater efficiency in milk and fat production can be effected by using home grown feeds, particularly those feeds which are high in protein. Therefore, where soybeans can be grown, their cultivation should be encouraged.

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