

# SOILING.

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During the summer of 1893 this station continued inquiry into soiling crops begun in 1891. The long continued drouth beginning in July and continuing into October, resulting in bare pastures and great loss to owners of all domestic animals, makes necessary thorough inquiry into all plants suitable to our soil and climate that mature during the months when experience shows us something must be prepared to supplement the pasture.

Much can be done by preparing well seeded acres, or ample area, to keep stock over short dry periods, but it is evident that such long drouths as we had during the past summer must be anticipated by fodders that can be cut in succession, and of such character as the different objects the feeder has in view demand. It is the purpose of this station to ascertain for the farmers of Iowa what plants suitable for green feeding grow most satisfactorily with us, what effect they severally have on milk and meat production; particularly what quality of butter can be made from each, and how much of each is sufficient for a milk cow, feeding steer, sheep, hog or work horse.

This experiment deals with the milk cow. We grew peas and oats that yielded 20,800 pounds an acre, second cut clover that weighed 14,400 pounds to the acre; rape that gave 54,000 pounds an acre; and sweet corn that made 3,600 pounds an acre. Four cows, a Shorthorn, Holstein, Red Poll and Jersey, were selected from the college herd and tied up in a cool, darkened, ventilated barn to test the fodders with, their milk being previously tested for fat. They were equally advanced in their periods of lactation, and had been grazing on abundant blue

grass pasture well shaded and watered; they had been fed 4 pounds of corn meal daily during their grazing period, and this amount of corn meal was continued with the several green feeds during the experiment, with six pounds each of hay daily. The cows were tied up July 18, at night, and on July 21 day and night, while they were being gradually accustomed to peas and oats; on July 26 and 27 their milk was sampled and tested to ascertain its per cent of fat. The milk of all the college cows is weighed night and morning during the whole year. They ate 125 pounds each of peas and oats daily. The cows were then gradually changed to green clover during five days where they had 125 pounds each, all they would eat up clean, until August 8 and 10, when for two days their milk was sampled and tested with the Babcock machine for fat per cents. On August 10th rape was gradually substituted for clover; they required 110 pounds of rape a day; on August 23 and 24 their milk was sampled and tested and sweet corn gradually substituted for rape. The corn was cut into two-inch lengths; it was fed entire as it grew, 110 pounds to each cow; the ears were just beyond the stage of table use. On September 4 and 5 the milk was sampled and tested, when the cows were put back into the pasture with the herd; and on the 10th of September the milk was sampled and tested to get a comparison between soiling and dry pasture grass.

The milk given by the cows during the two days at the close of each period was taken to the college creamery that is in operation for educational and experimental purposes every day in the year, and incidentally for commercial butter and cheese making. The milk was separated, ripened and churned and made into butter. The butter was scored on flavor by the creamery experts and taken to the chemist, who ascertained the specific gravity, melting point and volatile acid of each sample of butter made from milk produced by the several green fodders.

The following shows the average daily yield of milk and per cent of fat from the several green fodders by the several cows:

Average milk on fresh blue grass daily, July 18-19.		Fat, per cent.		Average milk daily on peas and oats, July 28-7		Fat, per cent.		Average milk on clover daily, August 9-10.		Fat, per cent.		Average milk on rape daily, August 23-4.		Fat, per cent.		Average milk on sweet corn daily, September 4-5.		Fat, per cent.		Average milk on dry blue grass daily, September 10.		Fat, per cent.	
lbs.	3.00	lbs.	3.40	lbs.	3.45	lbs.	3.25	lbs.	3.20	lbs.	3.20	lbs.	3.20	lbs.	3.20	lbs.	3.20	lbs.	3.20	lbs.	3.20	lbs.	3.20
28		31		26		23		23		20		20		20		20		20		20		20	
<b>HOLSTEIN NO. 708.</b>																							
<b>SHORTHORN NO. 209.</b>																							
lbs.	3.30	lbs.	3.30	lbs.	3.60	lbs.	3.20	lbs.	2.80	lbs.	4.00												
19		23.5		24		20.5		21		16													
<b>RED POLL NO. 402.</b>																							
lbs.	3.10	lbs.	4.00	lbs.	3.60	lbs.	3.40	lbs.	3.40	lbs.	4.20												
16		20		19		19		18		14													
<b>JERSEY NO. 353.</b>																							
lbs.	4.00	lbs.	3.60	lbs.	3.30	lbs.	3.45	lbs.	4.00	lbs.	4.00												
11		12.5		14		11		10		9													

It will be observed that taking cows from an abundant pasture at this season, keeping them confined in a barn and feeding them all they would eat of peas and oats, resulted in an increased flow of milk from all. The Holstein on peas and oats increased her milk 3 pounds and her fat 0.4 of 1 per cent. The Shorthorn increased her milk 4.5 pounds, while the fat per cent remained the same. The Red poll increased her milk 4 pounds and her fat per cent 0.9 of 1 per cent. The Jersey increased her milk 2.5 pounds, while the fat per cent decreased 0.4 of 1 per cent.

On green clover the Holstein's milk decreased from 31 to 26 pounds, the per cent of fat going up to 3.45. The Shorthorn's milk reached 24 pounds and her fat per cent 3.60. The Red Poll dropped down from 20 to 19 pounds, and her fat per cent to 3.60. The Jersey's milk increased from 12.5 to 14 pounds, but the fat per cent went down to 3.30.

On rape there was a general shrinkage of milk, and the fat per cent dropped in all except the Jersey: The Holstein lost 3 pounds of milk and 0.3 of 1 per cent of fat. The Shorthorn

lost 4 pounds of milk and 0.4 of 1 per cent of fat. The Red Poll's milk remained at 19 pounds, but the fat per cent decreased 0.4 of 1 per cent. The Jersey gave 3 pounds less milk, while the fat per cent increased 0.15 of 1 per cent. It will be of interest to note the composition of rape especially in this connection, subsequently treated.

On sweet corn the Holstein varied only 0.5 of 1 per cent in fat from her record on rape. The Shorthorn gave 1 pound more of milk than on rape, but decreased 0.4 of 1 per cent in fat. The Red Poll only varied 1 pound in milk from the record on rape; while the Jersey gave 1 pound less milk than on rape, but increased her fat to 4 per cent.

The cows were now turned out into the pasture with the rest of the herd, the 4 pounds a day each of corn meal being continued. At the end of five days the Holstein's milk had shrunk from 23 to 20 pounds, her fat per cent remaining unchanged. The Shorthorn lost 5 pounds of milk, her per cent going up to 4. The Red Poll's milk decreased 4 pounds, her fat per cent increasing to 4.20. The Jersey lost a pound of milk without a change in her fat per cent.

The consolidated yields of milk and per cents of fat of the four cows on the several feeds are as follows :

Average daily milk on blue grass, July 18-19.	Fat, per cent.	Average daily milk on peas and oats.	Fat, per cent.	Average daily milk on clover.	Fat, per cent.	Average daily milk on rape.	Fat, per cent.	Average daily milk on sweet corn.	Fat, per cent.	Average daily milk on dry grass.	Fat, per cent.
lbs. 74	3.35	lbs. 87	3.57	lbs. 83	3.48	lbs. 73	3.33	lbs. 72	3.35	lbs. 59	3.85

It will be seen that peas and oats had an immediately beneficial effect over pasture conditions, both as regards the quantity of milk and its quality. The clover did not maintain either entirely, but it will be seen that clover has a much greater per cent of water with a wider nutritive ratio. The rape is still more watery, as will be subsequently shown. The sweet corn did not make much variance in quantity of milk, the quality will be indicated from the scoring in the dairy of the butter made from the several milks and the analysis of the chemist. It will be seen that the cows shrunk seriously as soon

as they were turned out doors, which gives us strong reasons why something should be fed when pastures are dry, and also suggests that protection from heat and flies may be beneficial while the pasture is abundant, and raises the question whether the time required to tie up the cows and clean the stables is not amply paid for by the increased flow of milk consequent upon better feeding and more comfort.

The following table shows the pounds of butter fat, expert scoring on flavor, yields per acre and nutritive ratio of the tested crops, amounts of each eaten by each cow, and the dry matter contained in each.

Fresh Grass Milk.	Fat.	Peas and Oats Milk.	Fat.	Clover Milk.	Fat.	Rape Milk.	Fat.	Sweet Corn Milk.	Fat.	Dry Grass Milk.	Fat.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
74	2.47	87	3.10	83	2.88	73	2.43	72	2.41	59	2.27

**EXPERT SCORING ON FLAVOR OF BUTTER AT THE CREAMERY ON 45 BASIS.**

42	.....	42	.....	42	.....	39	.....	45	.....	42	.....
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**YIELDS PER ACRE OF TESTED CROPS**

Green Matter..	.....	lbs.	.....	lbs.	.....	lbs.	.....	lbs.	.....	.....	.....
Dry Matter ..	.....	20,800	.....	14,400	.....	54,400	.....	36,800	.....	.....	.....
		6,656		2,880		15,755		12,512			

**NUTRITIVE RATIO OF TESTED CROPS.**

1.54	.....	1.39	.....	1.54	.....	1.32	.....	1.13	.....	.....	.....
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**DRY MATTER OF TESTED CROPS.**

.....	.....	per ct.	.....	per ct.	.....	per ct.	.....	per ct.	.....	.....	.....
		32		20		10.58		34			

**AMOUNT EATEN BY EACH COW.**

Green Matter..	.....	lbs.	.....	lbs.	.....	lbs.	.....	lbs.	.....	.....	.....
Dry Matter ..	.....	125	.....	125	.....	110	.....	110	.....	.....	.....
		40		25		11.63		37.40			

The foregoing table shows: first, the pounds of butter fat indicated by the fat per cent. The milk of the two test days of each period was taken to the creamery, made into butter and scored by the creamery experts. Flavor only was considered. The milk from all the tested soiling crops made good butter

except that from rape. It will be observed that rape has a narrow nutritive ratio; that it is highly nitrogenous, but not much more so than peas. It is very watery, having only 10.58 per cent of dry matter. The decrease in amount of milk is accounted for in the low per cent of dry matter the plant contains. The butter became offensive in a few days after it was made. The chemical analysis shows that it is not very different from blue grass, peas and oats or clover; but this trial for dairy purposes gives unfavorable indications. That this is the case when the rape plant is made so large a per cent of the ration does not condemn it for dairy purposes, because, plants as rich in protein as it is are rare, and may be very advantageously fed in less amounts.

The indications from sweet corn confirm what Iowa dairy-men have believed concerning it. The butter from it scored highest.

But blue grass, peas and oats and clover, rated at 42 points, make butter that sells in the highest classes, while corn butter excels them. Rape, peas, and other highly nitrogenous plants would improve the corn ration so universal in the west, while they would take some points from its excellence. To what extent rape may be added to a corn ration without such lowering of the score as would prevent the butter from selling in the highest class will require farther research.

The clover does not give quite as good results as the peas and oats, but it will be seen that it has only about two-thirds of their dry matter, while the cows ate the same amount in green condition; besides, the peas and oats together, by analysis at this station have the greater per cent of protein. The low yield of peas and oats per acre was caused by growing them on a gravelly knoll, because it was convenient to the barns, and the clover was second growth, affected by the extreme drouth of the season. The amount of dry matter in the several rations is striking. From peas and oats each cow had 40 pounds, a very heavy ration, and considering the nutritive ratio of the two plants, a very rich one in protein. The cows got all they would eat of each green feed, but economic feeding would suggest much less. The full effect of the several

plants on butter flavor was the principal object in view. While the clover had only 20 pounds of dry matter, the appetite of the cows called for only the same amount of green feed as of peas and oats, and although there was only 10.58 per cent of dry matter in the green rape the cows only consumed 110 pounds of it daily. Palatability is a prime factor in the amount the animal will eat, and goes beyond the requirements of the animal's system sometimes. Sweet corn had 34 per cent of dry matter. The cows each had 37.40 pounds of dry matter each day, but the nutritive ratio of sweet corn is only 1 to 13, and while butter from it scored perfect, the milk from it made less butter than from the other green feeds. The greatest economy will come, perhaps, from feeding some of the more highly nitrogenous plants with corn in summer, as we find it necessary to do in winter.

During the summer of 1892 this station fed soiling crops in racks in the yard to eight cows, keeping four in the yard over night and getting comparisons with four in the pasture, alternating the lots. Peas and oats, clover and field corn were the plants used. This method gave us an increased flow of milk and was conducted for the purpose of avoiding tying up the cows and cleaning stables, and is a suitable way when help is scarce and pastures are failing.

#### WEIGHTS OF THE COWS.

The cows were weighed when they were tied up and again when they were turned out to grass. The Holstein lost 20 pounds; the Shorthorn lost 30 pounds; the Red Poll weighed the same on both occasions; and the Jersey lost 30 pounds. The weights were as follows:

	July 18. Pounds.	Sept. 5. Pounds.
Holstein . . . . .	1,080	1,060
Shorthorn . . . . .	1,100	1,070
Red Poll . . . . .	990	990
Jersey . . . . .	890	860

Bulletin 15, 1891, has a soiling experiment with six cows, where 12 pounds of corn meal, or 10 pounds of sugar meal, or its equivalent in ear corn, were fed to each cow

daily. The six cows during forty-nine days in the stable gained 53 pounds each, and with the same grain ration on pasture for the same time they gained 30 pounds each. Shorthorn No. 209 of Bulletin No. 15 is Shorthorn 209 of this experiment. With 12 pounds of corn meal, and soiling feed in the stable in 1891 she gained 25 pounds in weight, and with 4 pounds of corn meal and soiling feed in the stable in 1893 she lost 30 pounds. The gain and loss on this one cow are so slight that they cannot be taken as settling anything, but the gain in stable on similar green feeds in 1891, on a heavy corn ration being regular with all the cows; and the loss in this case with similar conditions being regular with one exception indicates that cows need not be fattened while giving milk on green feed and that any cow may be, by heavy feeding of corn meal.

The following is the chemical analysis of the several butters by Professor Patrick and his observations on the work in the laboratory:

CHEMICAL ANALYSIS OF THE BUTTER FATS.

FEEDS.	Blue grass.	Peas and oats.	Clover.	Rape.	Sweet corn.
Volatile acids, Wollny figure.	28.7	26.4	27.8	28.3	31.4
Specific gravity at 98 degrees Centigrade, water at 15½=1.	.8649	.8642	.8648	.8653	.8662
*Melting point.....	33.6	34.3	33.7	33.0	31.8
Scorings on flavor.....	42	42	42	39	45

\*Degrees Centigrade.

EXPLANATION OF TERMS, BY THE CHEMIST.

Volatile acids go hand in hand with flavor in butter. They distinguish butter fat, or milk fat, from the body fat of animals. Chief among the volatile acids is butyric. Cows fresh in milk produce butter richer in the acids than do the same cows when farther advanced in lactation; hence the comparatively high flavor of butter from fresh cows and the deficiency in flavor of that from strippers. The feeding of cotton seed meal, and perhaps of some other foods, tends



to reduce the percentage of volatile acids, and with it the flavor of the butter produced. A great problem in dairy feeding is to ascertain what foods will increase, or keep up, the percentage of volatile acids and at the same time produce a satisfactory yield of butter. The amount of volatile acids in butter is small, ranging usually between 4 and 6 per cent. The amount found by analysis is commonly expressed by chemists not in a percentage figure, but as in the above table, in what is called the "Reichert-Wollny figure" or simply the "Wollny figure"—this figure being the number of c. c. of alkali of a certain strength that is required to neutralize the volatile acids obtained from a certain weight (5 gms) of the butter fat.

The specific gravities were taken at the temperature of boiling water, but in the table are referred to water at 15½C. as unity. As a rule, the higher the percentage of volatile acids in a fat the higher the specific gravity; and this was the case in the five samples examined.

The melting point of butter fat depends somewhat upon the food, rising with a food which, like cotton seed meal, increases the stearine of the fat, and falling with foods which increase the oleine. The relation of volatile acids to melting point is therefore not always the same, but so far as the volatile acids themselves have influence, an increase in their percentage would lower the melting point. In the above table it will be noticed that the fat having the highest volatile acids (and flavor) and the highest specific gravity had the lowest melting point. The low scoring on flavor for the rape butter was not because of *deficiency* of flavor, but because of a positively *bad* flavor, supposed to have been imparted by the feed.