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Feeding Experiment with Dairy Cows.

By J. F. DUGGAR AND R. W. CLARK.

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Feeding Experiments with Dairy Cows.

By J. F. Duggar and R. W. Clark.

Summary.

With cotton seed at $8 per ton, cotton seed meal at $20, cotton seed hulls at $4, and sorghum hay at $6.67, butter was produced at a lower cost per pound on a ration consisting chiefly of raw cotton seed and hay than on one made up principally of cotton seed meal and hulls.

The cows did not greatly relish cotton seed and hence ate less than was desirable of the ration containing this; hence on the larger amounts eaten the oil mill ration afforded a larger daily yield of both milk and butter than did the farm-grown ration.

In two experiments the average daily amount of milk per cow was 17.5 pounds from the cotton seed ration and 24.3 pounds from the cotton seed meal ration; the daily production of butter per cow averaged .93 of a pound with the cotton seed and 1.19 with the oil mill ration, this being an increase of 38 per cent in milk and 28 per cent in butter. Nevertheless the low cost of the cotton seed ration made it the more economical, the average cost of the food required to make a pound of butter being only 10.4 cents when this ration was given and 15.3 cents when the hulls and meal ration was employed.

On account of the larger amounts of food consumed, the cows while receiving the cotton seed meal ration gained nearly half a pound a day in weight, while the cows eating cotton seed in smaller amounts lost .8 of a pound per day.

The cheapest butter was made by a Jersey heifer with her first calf, the food to make one pound of butter costing in this case only 6.4 cents when cotton seed was fed and 11.2 cents when cotton seed meal was given.

The manure (liquid and solid) dropped during the 16 hours of each day which the cows passed in the barn was carefully saved, analyzed, and applied to various crops.

The amount of manure, including sawdust bedding, per cow per night (of 16 hours) averaged 33.9 pounds when cotton seed was fed and 48.3 pounds when cotton seed meal was fed.

The manure made from the cotton seed and sorghum hay ration contained 10.7 pounds of nitrogen per ton; that from cotton seed meal and hulls contained 16.6 pounds, an increase of 55 per cent. in the amount of nitrogen per ton.

In percentages of phosphoric acid and potash the two manures were practically identical.

For one or two days the cows were kept stabled during the entire 24 hours and the amount of manure thus obtained (exclusive of bedding) was about double the amount secured by stabling the cows for 16 hours per day.

About one-half the manure was dropped out of doors.

Green rye at the rate of 52 to 54 pounds per day proved a satisfactory substitute for either sorghum hay or cotton seed hulls.

While the cows ate green rye the amount of milk slightly increased but the milk was slightly poorer than during the preceding period when only dry food was consumed.

An upland corn field from which the ears had been harvested, and in which cowpeas had been drilled between the corn rows, was grazed first by milk cows and

later by dry cows, the milk cows meantime receiving 3 pounds of cotton seed meal per day.

On this pasturage the yield of milk was 15.8 per cent greater and of butter 9.5 per cent greater than when the cows with the same grain feed ran on a good pasture of bermuda grass, carpet grass, lespedeza, etc.

The value of the product of butter and of the increase in live weight of the cows averaged $4.47 per acre of corn and pea field grazed, after deducting the cost of the cotton seed meal fed at the same time.

Introductory.

Under some conditions it is practicable for the dairyman to purchase a considerable proportion of the food which his cows consume. However, the temptation is to rely to too great an extent on purchased foods. These can be profitably used to a certain extent but rather as supplements to foods produced on the farm than as substitutes for farm-grown food. It is believed that any marked development of dairying and of beef production in the South is conditioned on the increased reliance on the foods which the fields and pastures produce. The feeder who buys thin cattle at a low price and, after a few months feeding, sells them at a higher price per pound, relies almost wholly upon cotton seed meal and hulls, but the stock raiser cannot afford to make the oil mill his principal depot of supplies.

Bearing in mind this necessity for avoiding large expenditures for purchased foods, we have planned a line of experiments intended to ascertain the extent to which farm-grown foods can be relied on in the feeding of dairy cows and the best crops for use as food in effecting this end.

The first experiments here reported are preliminary to this investigation and involve a comparison of a ration

made up chiefly of the most economical of all purchased foodstuffs, cotton seed meal and hulls, with one consisting chiefly of cotton seed and sorghum hay, both of which latter materials can be grown on every farm in the cotton belt.

PURCHASED VS. FARM-GROWN RATION IN 1900.

The farm-grown ration consisted of cotton seed and sorghum hay, with small amounts of wheat bran and corn meal added to improve the palatability and to increase the amount of cotton seed consumed. The endeavor was to make each cow eat daily at least 9 pounds raw cotton seed, 10 pounds sorghum hay, 3 pounds wheat bran, and 3 pounds corn meal; and the foods were mixed in these proportions. As much of the mixture was given to each cow as she would eat clean.

The purchased, or "oil mill" ration consisted of a mixture of 5.25 pounds of cotton seed meal, 10 pounds of cotton seed hulls, 3 pounds of wheat bran, and 3 pounds of corn meal. This mixture was also fed in amounts as large as the cows would eat and the quantity consumed was greater than had been expected when the experiment was planned.

The following prices for food stuffs used in calculating the cost of butter are assumed as average prices in this State for a series of years, except that sorghum hay, for which there is no market, is charged at a price somewhat above its average cost of production:

Cotton seed	$ 8.00 per ton.
Cotton seed meal	20.00 per ton.
Cotton seed hulls	4.00 per ton.
Wheat bran	18.00 per ton.
Corn meal	20.00 per ton.
Sorghum hay	6.67 per ton.

The cows used were as follows:

Name.	Breed,	Age.	Day sinces calving.	Weight when test began.
				Lbs.
Ada.....	Jersey.....	8 years..	110	816
Queen.....	Holstein....	8½ years..	81	980
Rozena.....	Holstein ...	8½ years..	119	1150
Hypatia.....	Jersey.....	4 years..	19	733
Annie.....	Jersey	10 years..	80	762

The experiment was divided into two periods of four weeks each, each period being preceded by a preparatory period of one week during which the cows were accustomed to the food which they were to receive during the next period.

During the first period Ada and Queen received the cotton seed ration, Rozena and Annie meantime getting the ration of cotton seed meal and hulls. During the second period the rations were reversed, so that each lot of cows was fed for one whole period on each kind of food. Annie refused the cotton seed ration and hence in the second period it was necessary to substitute Hypatia.

Composite samples of the milk were tested weekly by the Babcock test and the amount of fat thus found was converted into butter by the usual method of multiplying by one and one-sixth.

Amount, kind and cost of food eaten.

Period. (each 28 days.)	Cow.	Pounds food in 28 days.						Cost of food.	
		Cotton seed.	Sorghum hay.	Cotton seed meal.	C. S. hulls.	Wheat bran	Corn meal.	In 28 days.	Per day.
									Cents.
I	*Jan. 16 to Feb. 12.*								
I	Ada....	287	286	.....	.....	95	95		
I	Queen..	246	233	.....	.....	72	72		
II	*Feb. 23 to Mar. 22.*								
II	Rozena.	290	270	.....	.....	97	97		
II	Hypatia	193	212	.....	.....	64	64		
Total,	4 cows. ..	1016	1001	.....	.....	328	328	$13.57	12.1
II	Ada.....	.....	.....	220	419	125	125		
II	Queen. ..	.....	.....	246	467	140	140		
I	Rozena...	.....	.....	251	478	143	143		
I	Annie....	.....	.....	161	307	92	92		
Total,	4 cows. ..	.....	.....	878	1673	500	500	$21.63	19.3

The cows receiving the "oil mill" ration ate much more heartily than the others, the cotton seed making the "farm-grown" ration relatively unpalateable. The amounts eaten daily per head were as follows, taking the average for four cows on each food:

	Lbs.		Lbs.
Cotton seed, raw.....	9.07	Cotton seed meal	.7.83
Wheat bran	2.93	Wheat bran	4.38
Corn meal	2.93	Corn meal	4.38
Total concentrates..	14.93	Total concentr't's.	16.59
Sorghum hay	9.10	Cotton hulls	14.90
Total food	24.03	Total food.....	31.49

The average daily cost of food per day was 12.1 cents per cow with the farm-grown ration and 19.3 with the oil mill ration.

While it cost much more to feed the cows on the purchased ration, we may not pronounce this the least economical ration until we have noted the amount of butter produced by each.

Milk and butter produced by feeding a ration consisting largely of cotton seed and sorghum hay vs. one containing cotton seed meal and hulls.

Cotton seed and hay ration.				Cotton seed meal and hulls ration.			
Period.	Cow.	Milk.	Butter.	Period.	Cow.	Milk.	Butter.
		Lbs.	*Lbs.*			*Lbs.*	*Lbs.*
I	Ada.....	582.1	24.36	II	Ada.....	639.0	29.90
I	Queen.	586.0	27.76	II	Queen.	914.1	36.30
II	Rozena.....	638.3	29.00	I	Rozena.....	1179 5	46.16
II	Hypatia.....	514.7	28.60	I	Annie.....	639.1	34.90
Total,	4 cows, 28 days	2321.1	109.62	Total,	4 cows, 28 days	3371.7	147.26
Av.	Per cow, per day.....	**20.7**	**.98**	Av.	Per cow per day	**29.6**	**1.31**

The product obtained was greater with the oil mill ration, the increase in milk being 43 per cent and in butter 34 per cent. This increased production of milk and butter with the purchased ration is due largely, if not entirely, to the larger quantities of food consumed.

If we take 20 cents per pound as the value of the butter and assume that the manure and skim milk have sufficient value to pay for the labor of caring for the cows and making the butter, we have the following statement of the cost and profit on butter.

Financial statement.

	With farm grown ration.	With oil mill ration.
Value of butter from 4 cows, 28 days	$21.92	29.56
Cost of food, 4 cows, 28 days	13.57	21.63
Profit from 4 cows, 28 days	8.35	7.93
Cost of food per pound of butter, cents	12.1	15.2
Daily profit per cow, cents	7.5	7.1
Profit per pound of butter, cents	7.9	4.8

The butter was produced at a cost of 12.1 cents per pound when the cotton seed and hay ration was fed and of 15.2 cents per day when cotton hulls and meal were fed in maximum amounts. Yet the daily production was so much larger on the last mentioned ration that the average daily profit per cow is nearly the same with both rations, viz. 7.5 cents with farm foods and 7.1 cents with oil mill products.

Second Experiment; Purchased vs. farm-grown ration in 1901.

In January and February 1901 the experiment of the preceding winter was repeated, with slight modifications in the rations.

The foods were mixed in the following proportions, and the cows were allowed to eat as much of each mixture as they would.

Farm grown ration.	*Purchased ration.*
9 lbs. raw cotton seed.	5.25 lbs. cotton seed meal.
3 lbs. wheat bran.	3 lbs. wheat bran.
10 lbs. sorghum hay.	10 lbs. cotton seed hulls.

Prices used in calculating the cost of butter are the same as in the former experiment.

The experiment extended over a similar period of time, two periods of 28 days each, both preceded by a week of

preparatory feeding. The first period extended from January 1 to 28, 1901, the second from February 5 to March 4 inclusive.

Lot 1 consisted of two cows, and Lot II of three cows. The different number of cows in the two lots does not affect the accuracy of the results, for at the conclusion of the first period the rations were reversed, thus making each cow at different times during the experiment consume both rations.

The cows employed were as follows:

	Breed.	Age. Years.	Days since calving.	Weight when test began.
Ida	Jersey	5	110	810
Hypatia	do	5	16	740
Annie	do	11	37	795
Ada	do	9	48	830
Susan	do	3 (1st calf)	141	610

Amount, kind, and cost of food eaten.

Period.	Cow.	Lbs. food in 28 days.					Cost of food.	
		Cotton seed.	Sorghum hay.	Cotton seed meal.	Cotton seed hulls.	Wheat bran	In 28 days.	Per day.
								Cents.
I	Ida	258	207	.....	.....	86		
I	Hypatia	275	242	.....	.....	92		
II	Annie	175	135	.....	.....	58		
II	Ada	200	180	.....	.....	66		
II	Susan	168	162	.....	.....	56		
Total,	5 cows	1076	926	.....	.....	358	$10.61	7.5
II	Ida	.....	.....	235	449	134		
II	Hypatia	.....	.....	272	519	155		
I	Annie	.....	.....	193	368	110		
I	Ada	.....	.....	256	490	147		
I	Susan	.....	.....	189	360	108		
Total,	5 cows	.....	.....	1144	2186	654	$21.60	15.4

As in the former experiment we were unable to induce the cows to eat the desired amount of the cotton seed ration.

The food consumed per head daily averaged as follows:

	Lbs.		Lbs.
Cotton seed, raw ...	7.68	Cotton seed meal...	8.17
Wheat bran	2.56	Wheat bran	4.66
Total concentrates..	10.24	Total concentrates..	13.83
Sorghum hay	6.61	Cotton seed hulls...	15.60
Total food	16.85	Total food	29.43

The average daily cost of food was 7.5 cents per cow with the farm-grown ration and 15.4 cents with the oil mill ration. However, the more expensive ration gave the larger product, as appears below:

Milk and butter produced by feeding in 1901 a ration consisting largely of cotton seed and sorghum hay versus one containing cotton seed meal and hulls.

Cotton seed and hay ration.				Cotton seed meal and hulls ration.			
Period.	Cow.	Milk.	Butter.	Period.	Cow.	Milk.	Butter.
		Lbs.	*Lbs.*			*Lbs.*	*Lbs.*
I	Ida.....	359.2	21.09	II	Ida.....	523.8	29.00
I	Hypatia.....	532.7	30.44	II	Hypatia.....	640.3	26.73
II	Annie.....	380.9	22.42	I	Annie.....	607.8	32.22
II	Ada	409.5	22.70	I	Ada.....	549.2	28.79
II	Susan.....	318.6	26.39	I	Susan.....	446.3	31.76
Total...	5 cows, 28 d'ys	2000.9	123.04	Total...	5 cows, 28 d'ys	2767.4	148.50
Av. per	cow per day	**14.36**	**.88**	Av. per	cow per day	**19.0**	**1.06**

The purchased ration afforded an increase over the farm-grown ration of 32 per cent. in milk and 21 per cent in butter. Of course this increase must be attrib-

uted chiefly to the fact that larger amount of the former were consumed on account of its greater palateability.

With butter at 20 cents per pound and food stuffs at same prices as in the former experiment we obtain the following:

Financial Statement.

	With farm-grown ration.	With oil mill ration.
Value of butter from 5 cows, 28 days.....	$24.61	$29.70
Cost of food, 5 cows, 28 "	10.61	21.60
Profit from 5 cows, 28 "	14.00	8.10
Cost of food per pound of butter, cents.	8.6	15.4
Daily profit per cow, cents	10.0	5.8
Profit per pound of butter, cents	11.4	4 6

The farm-grown ration afforded a greater profit whether we use as a basis the daily profit per cow or the profit on each pound of butter; this latter profit was 11.4 cents when the cotton seed ration was fed and 4.6 cent when the meal and hulls ration was employed.

Attention is called to the excellent record made by the Jersey heifer Susan.

Although she had calved nearly five months before her experimental feeding began, yet she averaged 1.14 pounds of butter per day during the 28 days while receiving cotton seed meal.

AVERAGE RESULTS OF THE TWO EXPERIMENTS.

Taking the averages of the figures in the two experiment we find:

	With cotton seed ration.	With oil mill ration.
	Cents.	Cents.
Cost of food per pound of butter.....	10.35	15.3
Daily profit per cow	8.75	6.45
Daily production of butter per cow, lbs...	.93	1.19
Daily production of milk per cow, lbs...	17.53	24.3

With the oil mill ration the daily production of butter was larger by 28 per cent and the daily flow of milk by 38 per cent. But the amount of food consumed, and hence the daily cost, was so much greater than with the farm-grown ration that the latter was decidedly more profitable.

EFFECTS OF RATIONS ON WEIGHT AND HEALTH OF COWS.

Effect of food on live weight.

	Period beginning.	Weight at beginning.	Weight at end of period.	Gain (+) or loss (—) in 28 days.	
				On farm ration.	On oil mill ration.
Ada	Jan. 16, 1900.	816	832	+ 16	
Queen	do	980	970	— 10	
Ada	Feb. 23, 1900.	862	861	....	— 1
Queen	do	1003	1072	.....	+ 69
Rozena	Jan. 16, 1900.	1150	1175	.....	+ 25
*Annie	do	762	775	.....	+ 13
Rozena	Feb. 23, 1900	1152	1165	+ 13	
*Hypatia	do	703	705	+ 2	
Ida	Jan 1, 1901.	810	765	— 45	
Hypatia	do	740	700	— 40	
Ida	Feb. 5, 1901.	790	795	.....	+ 5
Hypatia	do	730	755	.....	+ 25
Annie	Jan. 1. 1901.	795	767	.....	— 28
Ada	do	830	840	.....	+ 10
Susan	do	610	610	.....	0
Annie	Feb. 5, 1901.	745	697	— 48	
Ada	Feb. 5. 1901.	845	780	— 65	
Susan	Feb. 5, 1901.	610	585	— 25	
Total net gain				—202	+ 118
Average per cow, per period of 28 days				22.4	13.3
Average per cow, per day				— .8	+ .5

* Hypatia substituted for Annie in 2d period.

The gains in live weight during the first two feeding periods are not of particular interest so far as the rations are concerned, but they seem to depend upon the individuality of the cows. Ada gained 16 lbs. on the farm-grown ration and practically held her own on the "oil mill ration" losing only 1 pound. Queen lost

10 pounds on the farm-grown ration and gained 69 lbs. on the "oil mill ration." With the other two cows there was a slight gain in both periods.

On an average the cows on cotton seed lost in weight .8 of a pound per day, while those on the meal and hulls ration, consuming more food, gained .5 of a pound daily. The rations fed during the second experiment were decidedly laxative and the cows showed it in the milk yield and in the loss of live weight. In 1900 the raw cotton seed fed constituted 37.7 per cent of the "home-grown ration," while in 1901 it constituted 45.50 per cent of the "home-grown ration."

In 1900 the cotton seed meal fed formed 24.8 per cent of the "oil mill ration" and in 1901 it formed 27.7 per cent.

The table of live weight shows that in the second experiment all the cows lost in weight when on the farm-grown ration, while only one fell off on the "oil mill ration." The effect of cotton seed and cotton seed meal varied with the different animals, the greatest scouring being with cotton seed. In the first experiment Rozena, a very large cow, consumed an average of 8.9 pounds of cotton seed meal daily and appeared well in every way, while in the second period she consumed 9.6 pounds of cotton seed and did not show the effects for three weeks, when she scoured very heavily and fell off in milk flow. This was undoubtedly due to the large amount of oil in the cotton seed. In the second experiment Susan, a small heifer, took 6 pounds of cotton seed per day for the first period and appeared at her best during the whole of the month, but six days after being on cotton seed meal in the second period, getting 6.7 pounds per day, she commenced to scour and fell off in milk flow. This could not be due to a larger amount of oil in the ration, but

probably to the influence of the previous month's feeding of cotton seed, modified by the individuality of the cow. A cow that scours, even though it be slight, can not do her best at the pail.

In feeding cotton seed and cotton seed meal, as well as other feed stuffs, one must not rely on tables entirely, but be guided largely by the individuality of the animal with which he is dealing. The amounts of cotton seed meal used in the above experiments are larger than the writers would advise.

THE AMOUNT AND QUALITY OF MANURE COLLECTED FROM COWS ON DIFFERENT RATIONS.

First experiment, 1900. The manure, both liquid and solid, was saved every day, except that dropped when the cows were out of the barn and in bare lots where they spent the time between 8 a. m. and 4 p. m. Hence the manure actually saved consisted only of that dropped during 16 hours of each day, or of that voided during two-thirds of the time.

The liquid manure was saved by the use of sawdust as bedding material. The manure was removed every day to a shed, the roof of which consisted of 12-inch boards without battens, and hence having small cracks every twelve inches. This leak kept the manure moist but seems not to have resulted in any appreciable amount of leaching.

The manuure (including sawdust) collected during the time that the cows stood in the barn was as follows:

	Lbs. in 28 days, 2 cows.	Lbs. daily per cow.
From cotton seed and hay ration, 1st 28 days.....	1785	
From do 2nd 28 "	1700	
Total and average.....	3485	31.04
From cotton seed meal and hulls ration, 1st 28 days,	2115	
From do 2nd 28 "	2430	
Total average.....	4545	40.6

These several lots of manure were applied to various farm crops; to ascertain the real or agricultural value of the two kinds of manures we must wait until the crop returns for several years can be reported.

No analyses of the manure was made in the experiment conducted in 1900.

The bedding used was fresh yellow fine sawdust, which in the first experiment was dry enough, but that used in the experiment of 1901 was too moist to be entirely satisfactory. The amounts of sawdust used per period (and included in the figures given above for manure) were with the cotton seed ration 391 and 639 pounds in the respective periods; with the cotton seed meal ration 520 and 644 pounds, respectively.

Second experiment, 1901. The same method as in 1900 was employed in collecting and handling the manure dropped during the 16hours per day that the cows spent in the barn. Only during the second period of this experiment was the manure kept separate and weighed.

The weights given are those obtained by weighing the bulk of manure and soiled bedding at the conclusion of the experiment.

The data follows:

	Lbs. manure from 2 cows, 28 days.	Lbs. manure daily per cow.
From cotton seed and hay ration....1900		35.7
From cotton s. meal and hulls ration.3138		56.0

These two lots of manure, each collected during parts of 28 days, were applied to farm crops, and the effects of these two classes of cow manure as compared with each other, with commercial fertilizers, and with no fertilizer, will be recorded in future bulletins of this Station.

The two lots of fertilizers collected as above during the last 28 days of the experiment, were carefully sampled at the end of the experiment and promptly analyzed; and the following table gives the results calculated by us from the analyses made by the chemical department of the Station:

Nitrogen, phosphoric acid, and potash in cow manure, 1901.

	From cow manure.	
	Cotton seed and hay ration.	C.S meal and hulls ration.
*Composition.**		
Nitrogen, ...per cent.....	0 535	0.830
Phosphoric acid, per cent.....	.340	0 350
Potash, ...per cent.....	.500	0.485
Moisture, ..per cent.....	64.00	66 140
Pounds in 1 ton of manure.		
Nitrogen, ...lbs.....	10 7	16 6
Phosphoric acid,.....lbs	6.8	7 0
Potash, ...lbs	10.0	9 7

The matter that is most worthy of note in the table above is the fact that manure made from a diet consisting largely of cotton seed meal and hulls is 55 per cent. richer in nitrogen than that made from the cotton seed and hay ration; a ton of the former contains 16.6 pounds of nitrogen as compared with 10.7 pounds of nitrogen in the manure from the latter or farm ration. As regards phosphoric acid and potash the two manures are on a practical equality.

* In 1901 the manure dropped during the day when the cows were confined for the *entire 24 hours* was also analyzed, the comparison being almost exactly the same as that of the manure saved during the second period of 28 days (see table above). There was in this fresh manure made from cotton seed, etc., 68 3 per cent. moisture; 0.515 per cent. nitrogen; 0.30 per cent. phosphoric acid; 0.39 per cent. potash. In the manure made from cotton seed meal the percentages were respectively, 68 37; 0.78; 0.325; 0.40. The only notable difference is in the nitrogen, of which the manure from the oil mills ration contained 51 per cent. more than was found in the cotton seed ration.

PROPORTION OF TOTAL EXCREMENT DROPPED IN BARN.

In order to determine what proportion of the manure was dropped in the barn and what percentage in the lots during the eight hours that the cows daily passed in the latter, two cows getting the farm ration and two receiving the purchased foods were kept in the barn for 24 and 48 hours after the close of the experiment, the rations meantime being continued without change.

Solid & liquid excrement per cow in 24 hours.

Cotton seed ration.				Cotton seed meal ration.			
Cows.	Date.	Total excrement and sawdust.	Solid and liquid excrement.	Cows.	Date.	Total excrement and sawdust.	Solid and liquid excrement.
		Lbs	*Lbs.*			*Lbs.*	*Lbs.*
Ada and Queen	Feb. 13 & 14, 1900	55 8	47 8	Ada and Queen	Mar. 23&24, 1900	87 2	72.6
Rozena & Hypatia.	Mar. 23&24, 1900	73 1	56.8	Rozena & Annie.	Feb. 13& 14, 1900	61.5	46.1
Ada and Susan.	Mar 6, 1901 ...	53.8	...	Queen & Hypatia.	Mar. 6, 1901....	103 8	
Average ...	per cow	60.9	...	Average ...	per cow.....	84.2	
Average ...	per 1000 lbs live weight.	72 5		Average. ..	per 1000 lbs. live weight.	89 3	

The average amount of solid and liquid droppings and bedding per cow was 60.9 pounds per day with the ration containing cotton seed and 84.2 pounds per day with the ration containing cotton seed meal.

In 1900, with the cotton seed ration, the average amount of solid and liquid excrement dropped per cow in 24 hours (excluding bedding) was 52.3 pounds; the average daily amount of excrement (free from sawdust) collected during the 16-hour stabling period of each day was only 21.9 pounds.

In 1900, with the cotton seed meal ration, the average amount of excrement, free from sawdust, dropped per cow in 24 hours was 59.4 pounds; the average amount collected during the 16 hours of stabling was only 30.2 pounds.

Apparently about one-half the manure was dropped in the barn and about one-half in the lots.

This statement is important because the manure dropped on the lots or pastures usually suffers greater losses, and hence is worth less than that collected while the cows are in the stable. However, the high value of manure from grain fed cows should prompt every dairyman to gather and protect the manure from the lot as well as that from the barn.

In conclusion let us note that the manure from the cotton seed meal ration was greater in amount and much richer in nitrogen than that from the cotton seed ration. Taking the average amounts of manure in all cases where the cows were confined for the whole day and using the analysis of the samples collected in the last periof of 28 days in 1901, we find that the daily excretion of liquid and solid excrement (including bedding) contained plant food as follows:

	Lbs. nitrogen.
60.9 lbs. manure from cotton seed ration.....	.306
84.2 lbs. manure from cotton seed meal ration....	.700

With the cotton seed meal ration the daily output of nitrogen in the manure was more than twice as great, and the amounts of phosphoric acid and potash considerably larger than with the ration made up largely of cotton seed.

GREEN RYE SUBSTITUTED FOR COTTON SEED HULLS AND FOR SORGHUM HAY.

For 3 weeks beginning March 22, 1900, the four cows which had been used in the experiment comparing a farm-grown with a purchased ration, were fed on green rye as a substitute for the cotton seed hulls and for the sorghum which they had been eating during the second period. The grain ration of the second period was continued in same proportions but in greatly reduced amounts. The rye was in full bloom and rather too old. Excluding the first, or preliminary, week, we find that the result for period III, consisting of 14 days, were as stated below:

Food consumed and milk and butter afforded by 2 cows in 14 days from different rations.

	Lbs. food in 14 days.				Gain or loss in weight	Cotton seed ration.		Cotton seed meal ration.	
	Green rye.	Cotton seed.	Cotton seed meal	Bran and corn mixture. 1:1.		Milk.	Butter.	Milk.	Butter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Ada	773	....	50 0	36 0	+ 8	.....	....	298.9	12 73
Queen	689	.....	73.4	83 9	— 32	.....		424.0	13.33
Rozena	783	88 8	.....	59 8	— 7	364 8	13 15	.....	.....
Hypatia	731	52 8	.....	35.2	— 14	272 9	15 27	.....	.....
Total, 2 cows	.....	...	.....	.....	.....	**637 7**	**28 42**	**722.9**	**26 06**

Counting green rye at $2.00 per ton and other foodstuffs at prices before mentioned, we find that the cost of food to make one pound of butter was 15.4 cents when cotton seed meal was fed and only 10.5 cents when cotton seed was fed.

This difference in favor of cotton seed over cotton seed meal as an economical producer of butter is apparently too great to be attributed to individual peculiarities of the cows of the two lots, which were chosen with reference to their practical equality.

Direct comparison of green rye as a substitute for either cotton seed hulls or sorghum hay can not be made in this experiment. However the substitution of rye for cotton seed hulls, and also for sorghum hay, reduced the cost of butter, partly perhaps because the large amount of green rye eaten made it practicable to reduce the amount of concentrated food.

Comparing the average daily product during period III with that of the last two weeks of period II, and making no allowances for the fact that the cows while on rye were further removed from time to time of calving than when receiving sorghum or cotton seed hulls, we find:

(1) That the substitution of 52 lbs. of green rye for 14.9 lbs. of hulls (grain also being reduced when rye was fed thus changing the nutritive ratio from 1:4 to 1:3.7), was accompanied by a shrinkage of 19 per cent. in butter and 9 per cent in milk.

(2) That the substitution of 54 lbs. of green rye for 9.1 pounds of sorghum hay (grain also being reduced when rye was fed, changing the nutritive ratio from 1:6.5 to 1:7.3) increased the yield of milk by 18 per cent. and the yield of butter to the extent of 6 per cent.

The results of feeding rye were highly satisfactory

for they show that rye was practically able to maintain the normal product (actual yield corrected for advance in location) of butter and to slightly increase that of milk and that its use allowed the daily ration of concentrated food to be decreased to the extent of more than 5 pounds per day, without materially impairing the amount of product. These facts and figures point to an increased use of green crops in late winter and early spring as an effective means of reducing the bill for purchased foodstuffs. An uninterrupted succession of crops for feeding green (soiling) may be had by the use of rye, wheat, common oats, hairy vetch (mixed with small grains), turf oats, and sorghum, etc.

Since the health and working capacity of cows are so greatly improved by soiling crops they should find increased favor.

Effect of green food on richness of milk.

It is a common belief that milk made from green food contains more water and less fat than that from dry foods. The results of the few experiments made on this point do not bear out the popular belief.

Our results on this point were obtained by making a composite test for butter fat, once a week.

It should be recollected that these determinations of fat were not begun until after the cows had been eating rye for a week. For comparison, we give the percentages of fat found in the milk of the same cows for the weeks beginning March 9 and March 16, 1900, at which time they were receiving only dry food, and a heavier grain ration (though similar in kind) than was given with the rye.

Per cent. of fat in milk; results of composite weekly tests.

Name.	On dry food, and heavy "grain" ration.			With green rye, and moderate "grain" ration.			
	Date.	Per cent. fat.		Date.	Per cent. fat.		Loss on green food.
							%
Ada	Mar. 9–15	3 7	3.85	Mar. 30-A.5.	3.5	3.65	.20
	Mar. 16–22	4 0		Apr. 6–12	3.8		
Queen	Mar. 9–15	3.2	3.30	Mar 30-A. 5.	3.	2.90	.40
	Mar. 16–22	3.4		Apr. 6–12	2.8		
Rozena	Mar 9–15	4.1	4.15	Mar. 30-A. 5	3.0	3.10	1.05
	Mar. 16–22	4.2		Apr. 6–12	3.2		
Hypatia	Mar. 9–15	5.0	4.80	Mar. 30-A. 5	4.8	4.80	.00
	Mar. 16–22	4.6		Apr. 6–12	4 8		
Average decrease in % fat	.....	.....	.....	.....	.....	.....	.41

The uniformity of the figures indicate a decrease in per cent. of fat in the period when rye was fed. It cannot now be said whether it was due to the green food, to temperature conditions, or to a large reduction in the grain ration. The effect of green foods as fed in the South on the percentage of fat in the milk requires further study.

DIGESTIBLE NUTRIENTS IN THE SEVERAL RATIONS FED.

The following table given the amount of digestible nutrients consumed per day in the different periods in comparison with the German or Wolff-Lehmann Standard, which represents the daily requirements of an average cow in full flow of milk:

Digestible nutrients in rations fed.

Ration.	Average weight of cows.	Dry matter.	Digestible nutrients			Milk per day.	Nutritine ratio.
			Protein.	Carbohydrates.	Ether extract.		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Wolff-Lehmann Standard.	1000	29	2.5	13	.5	22	1:5.7
"Farm-grown," 1900..	915	18 75	1 85	9.21	1.81	20.7	1:7.3
"Oil mill," 1900.....	957	28.19	3.82	11.98	1.01	29 6	1:3.7
"Farm-grown," 1901.	772	13.07	1.37	5.76	1.42	14.3	1:6.6
"Oil mill," 1901.....	752	25 46	3.64	8.36	1.38	19.0	1:3.2
Rye & cotton s., 1900..	970	20 9	2 2	11.2	1 31	22.7	1:6.5
Rye & c. s. meal, 1900.	960	20.6	3.21	10 71	.90	25.8	1:4.0

Speaking in general terms, protein is that part of the food that goes to make milk, muscle, bone, etc., while carbohydrates (starch, sugar, etc.) and ether extract (fat, etc.) are used as fuel and to give force. Protein is nitrogenous material, and carbohydrates and ether extract are non-nitrogenous. Both classes of compounds must be present in the food to keep the body in its normal working condition.

The average daily ration per cow was as follows:

Cotton seed ration—
5.6 lbs. cotton seed.
3 7 lbs bran and corn mixture.
54 lbs. green rye.

Cotton seed meal ration—
4.4 lbs. cotton seed meal.
5.0 lbs. bran and corn mixture
52 lbs. green rye.

It should be noticed that the cowing eating the cotton seed ration could never be brought up to full feed, or the amount necessary to produce a full flow of milk; in one experiment their ration dropped nearly down to half

what the Germans have found to be desirable for a cow to eat.

On the other hand the cows getting cotton seed meal in all cases consumed more protein than necessary.

The nutritive ratio is the number of times that the ratio of the amount of protein (taken as 1) to the total amounts of carbohydrates and fats, the fats having first been multiplied by 2¼. The nutritive ratio was narrow (represented by a small number) when cotton seed meal was fed, and wider (or less rich in nitrogen or protein) when cotton seed was fed.

Value of cowpeas in corn fields as pasturage.

For a period of 19 days, October 7 to 25 inclusive, 1900, three Jersey cows were grazed in a corn field from which the ears had been pulled, the grazing consisting principally of cowpeas, of what remained of the corn blades, and of a little crab and crowfoot grasses.

The corn was planted March 28 in rows five feet apart. Half way between the corn rows was a row of drilled Wonderful cowpeas planted June 4, without fertilizer. The yield of corn was about 25 bushels per acre.

While the cows were grazing in the corn field on cowpeas each received a daily allowance of 3 pounds of cotton seed meal.

From September 23 to October 6 each cow also consumed 3 pounds of cotton seed meal per day. During this earlier period of three weeks, they grazed in a large pasture of bermuda, lespedeza, (Japan clover, carpet grass, etc.) so that the yields made on pea vines can be properly compared with those made on ordinary pasturage. The following table shows the amount of milk and butter afforded daily by each cow:

Average amount of milk and butter produced daily.

Cow.	Milk from		Butter from	
	Mixed pastur'ge.	Cowpeas, etc.	Mixed pastur'ge.	Cowpeas, etc.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Ida	23.94	25.53	1.03	1.13
Houron	9.72	15.5	.81	.97
Susan	17 64	18.37	1.00	1.01
Average per cow, daily	17.1	19.8	.95	1.04
Per cent. increase		15 8		9.5

Comparing the product obtained when the cows grazed on cowpeas with that made from ordinary pasturage, we find that the cowpeas gave an average increase of 15.8 per cent in milk and 9.5 per cent in butter. It should be noted that this increase occurred in spite of the fact that the cows were further advanced in the period of lactation when grazing on cowpeas than when on ordinary pasture.

The total amount of product obtained from the three cows during the 19 days while they grazed on cowpeas in a corn field of 3.03 acres was 1129.5 pounds of milk and 59.17 pounds of butter. During this time the three cows consumed a total of 171 pounds of cotton seed meal.

The three cows Ida, Susan, and Houron, during the 19 days while pasturing on cowpeas made gains in live weight of 2687 pounds, subsisted for a period of 85 pounds for the lot. When the field was grazed so close as to threaten to reduce the milk flow, these three cows were removed and three dry Jersey cows were substituted. These three dry cows, with a total initial weight of 2687 pounds, substituted for a period of 9 days on what remained of the grazing on 3.03 acres, meantime receiving no other food whatever and making gains of 12, 16, and 25 pounds, a total of 53 pounds for the lot. Adding this to the 85 pounds gained by the cows giving milk, we have a total gain in live weight of 138 pounds.

The returns from grazing 3.03 acres of cowpeas are brought out by the following:

Financial statement.

By 59 17 lbs. butter, @ 20c		$11.80
By 138 lbs. increase in live weight, @ 2½c		3.45
To 171 cotton seed meal, @ $20	$ 1.71	
Balance (value of 3.03 acres pasturage)	13 54	
Total	$ 15.25	$15 25

Since $13.54 represents the returns from 3.03 acres, the value of the grazing on one acre is $4.47.

The peas were planted for their fertilizing value and the butter removed practically none of this. Hence the cost of growing the peas should be charged in the fertilizer bill of the following crop, and not to the butter produced. However, if it be insisted that this is a proper charge against the cows the expense consists only of the cost of seed, labor of dropping and of covering, the total being somewhat less than a dollar per acre.

If we charge all of this expense of growing the peas to the cows giving milk and entirely neglect the gains made in live weight (the value of which was greater than the cost of growing the peas) the cost of concentrated feed and of pasturage was 8 cents per pound of butter. Balancing gains in live weight against cost of making the pea crop, we have 2.9 cents as the cost of purchased food per pound of butter.

Since there are more farmers interested in beef production than in commercial dairying, we have made an estimate as to the amount of growth of beef cattle that might be expected on an acre, using Thorne's figures as to the relative amounts of food required to make a pound of butter and of beef. By this method we estimate that an acre of grazing of this character made without the aid of any other food, animal products equal to about 80 pounds of increase in live weight. This is confessedly only an estimate but it is in accord with the small amount of data from other sources which is available on this subject.