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*W. A. Dixon*  
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*Legume*

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## Vetch, Cowpea, and Soy Bean Hay as Substitutes for Wheat Bran.

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By J. F. DUGGAR.

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## VETCH, COWPEA AND SOY BEAN HAY AS SUBSTITUTES FOR WHEAT BRAN.

BY J. F. DUGGAR.

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### SUMMARY.

The object of the feeding experiments herein described was to ascertain whether hay made from hairy vetch, cowpeas and soy beans could be advantageously substituted for most of the wheat bran in the ration of dairy cows.

The following values per ton were used in calculating the cost of food:

Wheat bran, \$20.00; vetch hay, \$10.00; cowpea hay, \$10.00; cotton seed \$12.00; cotton seed meal, \$20.00; cotton seed hulls, \$5.00.

Vetch hay proved fully equal in feeding value to a similar weight of wheat bran. By this substitution the cost of the food required to make a pound of butter was reduced 25 per cent., which is equivalent to a monthly saving of \$22.20 in a herd of twenty cows.

With the vetch ration the cost of food for one pound of butter averaged 10 cents in contract with 13.4 cents when wheat bran was fed.

The waste in feeding vetch hay was, with most cows, about 6 per cent. of the amount offered and with cowpea hay about 16 per cent.; the latter residue, being unless, is charged as a part of the ration.

That portion of the cowpea hay actually eaten proved fully equal in feeding value to a similar weight of wheat bran. Charging the cows with all the cowpea hay offered them, we find that cowpea hay had 86 per

cent. of the feeding value of wheat bran, one ton of this hay being equal to 1720 pounds of wheat bran.

When wheat bran was worth \$20.00 per ton cowpea hay was worth \$17.20 and vetch hay \$20.00.

The monthly profits per cow were \$4.65 on the vetch ration and \$4.35 on the cowpea ration.

One of the Jersey cows used in this test produced butter at a cost for food of only 8 1-3 cents per pound, when fed on the vetch ration.

Running cowpea hay through a feed cutter did not decrease the waste in feeding this food.

Four and a half per cent more butter was produced with soybean hay than with cowpea hay, if we take account of the portion of each actually eaten; however a larger proportion of the coarse stems of the soybean hay was left uneaten.

When corn hearts was substituted for wheat bran the yield of butter was increased by 8 per cent.

The following combinations of food stuffs made satisfactory daily rations for Jersey cows weighing between 700 and 800 pounds and producing a little more than a pound of butter per day:

- (a) 4 lbs. cotton seed.  
     2 lbs. wheat bran.  
    11.8 lbs. vetch hay.  
     Total 17.8 lbs.
- (b) 6.5 lbs. cowpea hay.  
     9.6 lbs. cotton seed hulls.  
     4.8 lbs. cotton seed.  
     2.4 lbs. cotton seed meal.  
     2.4 lbs. wheat bran.  
     Total 25.7 lbs.
- (c) 6.6 lbs. soybean hay.  
     8.6 lbs. cotton seed hulls.  
     4.3 lbs. cotton seed.

2.2 lbs. cotton seed meal.

2.2 lbs. wheat bran.

Total 23.7 lbs.

Account was kept of the manure produced during certain periods, and it was found that this was produced at the rate of 1,749 pounds per month, or 3 1-2 tons per cow during a stabling period of four months.

Almost exactly half of the manure was left in the barn during the stabling period of 16 hours and an almost exactly equal amount was deposited during the 8 hours while the cows were in the lots.

#### THE GENERAL PLAN OF THE EXPERIMENTS.

The chief aim of the experimental feeding of dairy cows as conducted by the Agricultural Department of this Station during the past four years has been to ascertain the means by which the dairymen might reduce his expenditures for purchased food.

The chief profits in live stock consist in using them as the means of improving the soil and of advantageously marketing the crops grown on the farm. Hence the larger the proportion of farm-grown food and the smaller the proportion of purchased material in the ration of an animal the greater the profit.

The proximity of cotton seed oil mills, the relative cheapness of cotton seed meal and hulls, and the convenience with which these by-products can be fed, have had the effect of making many southern farmers too dependent upon purchased foods. In Bulletin No. 114, issued in 1901 by this department, it was shown that at prices then prevailing a home-grown ration of cotton seed meal and sorghem hay afforded less butter, but at a lower cost per pound, than a diet of cotton seed meal and hulls.

The southern dairyman incurs considerable expense in the purchase of wheat bran. The experimental feeding of dairy cows during the past two winters has had for its object to learn whether the dairyman could advantageously reduce the amount of wheat bran often fed. Instead of wheat bran, we fed in 1901-2 vetch hay and the past winter cowpea hay. In composition these two hays are quite similar to wheat bran, as may be seen in the table of composition below, giving the composition of the foods used as determined by the Chemical Department of this station.

	In 100 pounds of food are:					
	Water.	Ash.	Protein Lbs.	Starch. sugar etc. Lbs.	Fat. Lbs.	Fiber. Lbs.
Wheat bran ..	9.21	7.17	15.19	51.84	4.59	12.00
Cowpea hay ..	9.84	12.18	13.62	34.66	4.08	25.62
Vetch hay ....	**20.30	5.79	17.15	32.12	2.14	22.50
Soy bean hay..	9.25	6.01	12.19	34.26	2.35	35.12
Corn hearts ..	10.21	2.49	10.75	58.95	7.76	9.84
Rice meal ....	8.54	9.14	10.56	49.97	8.30	13.55

\*Starchy matter, etc. \*\*Vetch hay, when analyzed, (Ala. Bul. No. 105), contained more water than when fed.

In each experiment six thoroughbred Jersey cows have been employed, carefully divided into two nearly similar lots. Each lot has been fed (in addition to a basal ration which was the same for all) for half of the time on wheat bran and during the other portion of the experiment on either vetch or cowpea hay instead. The effort has been to make each lot of cows consume as nearly as practicable as many pounds of wheat bran during one period as of hay during the other period of each experiment. In other words hay of hairy vetch or of cowpea has been substituted almost pound for

pound for wheat bran. Each cow in each lot did not receive exactly the same amount of food, but so far as practicable it was the aim to make the total amount of food of one lot equal, or nearly equal, to that of the other lot.

While the results have a very positive value for the dairyman they should also convey to the grower of beef cattle suggestions of almost equal value.

The details of the first experiment recorded below were under the immediate care of Prof. R. W. Clark. In the later experiments the writer was assisted by Mr. J. M. Jones and by students. To the intelligent care and interest of all of these are largely due the satisfactory results obtained.

#### HAIRY VETCH VERSUS WHEAT BRAN.

This experiment extended over a period of eight weeks during the winter of 1901-2. The rations were reversed at the end of four weeks, so that the cows which at first received an extra quantity of wheat bran later had an extra amount of vetch hay. The first week of each period was regarded as a preliminary period and, as usual, excluded from the record.

Every cow received daily a basal ration which averaged as follows:

- 4 lbs. uncooked cotton seed.
- 2 lbs. wheat bran.
- 5.2 lbs. vetch hay (average.)
- 11.2 lbs. total basal ration.

Besides the above, each cow in one lot received an additional amount of vetch hay, which varied with the appetite of the individual cow, and which averaged 6.6 pounds per cow daily, excluding the small amount which was offered but not eaten.

The other lot of cows was fed, besides the basal ration, an additional amount of wheat bran, which extra

allowance averaged 7 pounds per head daily. The rations of the two lots of cows were in time reversed so as to eliminate any possible inequality due to the individuality of the cows. For the sake of simplicity we shall hereafter speak of the one as the vetch ration and of the other as the bran ration.

The vetch ration consisted of a daily allowance of 17.8 pounds of food per day and the bran ration of 18.2 pounds. This gives slight advantage in the amount of food to the cows on the bran ration.

The following prices for food stuffs are assumed as average local prices on the farm for the last two winters:

Cotton seed, \$12.00 per ton.

Wheat bran, \$20.00 per ton.

Vetch hay, \$10.00 per ton.

Cowpea hay, \$10.00 per ton. The actual prices for a small portion of the food varied from this average; for example, the supply of home-grown peavine hay becoming exhausted before the conclusion of this experiment, it was necessary to buy a few bales at one dollar per hundred weight.

The vetch hay was of good quality, though it contained a small amount of coarse oat hay, it being necessary to sow oats or other grain with vetch to hold the slender vetch plant off the ground.

The cows used were as follows:

Lot.		Breed.	Age—Years.	Days since calving.	Weight when test began.
I	Ida .....	Jersey .....	6	143	831
I	Hazena* .....	do .....	3*	65	653
I	Hypatia .....	do .....	6	44	813
Av. I	Average .....	.....	.....	<b>84</b>	<b>766</b>
II	Lukie* .....	do .....	3*	108	699
II	Susan .....	do .....	4	68	672
II	Ada .....	do .....	10	99	831
II	Average .....	.....	.....	<b>92</b>	<b>734</b>

\*Heifers with first calves.



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.

From the table below it will be seen that the basal ration was the same for every cow, whatever the extra food consumed at the same time.

Period (each 21 days.)	Cows.	Pounds food in 21 days.					
		Vetch Hay Extra.	Wheat Bran Extra.	In basal ration.			
				Cotton Seed.	Wheat bran.	Vetch hay.	Total basal ration.
I	Dec. 19 to Jan. 9.						
I	Ida .....	157.6		84	42	108.4	234.4
I	Hazena .....	61.1		84	42	108.4	234.4
I	Hypatia .....	195.6		84	42	108.4	234.4
II	Jan. 16 to Feb. 6						
II	Lukie .....	74.6		84	42	108.4	234.4
II	Susan .....	166.1		84	42	108.4	234.4
II	Ada .....	179.6		84	42	108.4	234.4
<b>Total.</b>	<b>6 cows .....</b>	<b>834.6</b>		<b>504</b>	<b>252</b>	<b>650.4</b>	<b>1406.4</b>
II	Ida .....		159.6	84	42	129	255
II	Hazena .....		92.4	84	42	63	189
II	Hypatia .....		176.4	84	42	126	252
I	Lukie .....		126.0	84	42	84	210
I	Susan .....		168.0	84	42	122.5	245.5
I	Ada .....		168.0	84	42	126.0	252
<b>Total.</b>	<b>6 cows .....</b>		<b>890.4</b>	<b>504</b>	<b>252</b>	<b>650.5</b>	<b>1406.5</b>

The average daily cost of food per cow was 10.3 cents for the vetch ration and 14 cents for the wheat bran ration at the price assumed as an average for wheat bran, namely \$20.00 per ton.

Hence the vetch ration was the cheaper by 3.7 cents per cow per day or \$1.11 per month per cow. At this rate the saving through the substitution of vetch hay for wheat bran in a herd of 20 cows would be \$22.20 per month.

Only the vetch hay actually consumed is charged, for the reason that with most cows the amount of vetch hay left uneaten was very small. The percentages rejected by five of these cows during the time when large amounts of vetch hay were fed were respectively 1, 3, 7, 9, and 9 per cent. of the amount offered. Hazena and Lukie, however, could not be induced to eat the desired amount of hay and hence were on rather "short rations" (with corresponding shrinkage in yield) during the time that they were receiving the vetch ration.

The greater part of the waste consisted in the case of most cows of the coarser part of the oat plant, which was mixed with the vetch.

If the average proportion rejected by five cows, 6 per cent., be regarded as the usual waste and charged to the cows, it would change the relative results only by a small fraction of a cent per day.

The amount of milk and of butter produced by each cow on both rations are recorded for periods of 3 weeks in the following table:

*Milk and butter in 21 days from nearly equal amounts of vetch and wheat bran.*

Vetch Hay Ration.				Wheat Bran Ration.			
Period.	Cow.	Milk lbs.	Butter lbs.	Period.	Cow.	Milk lbs.	Butter lbs.
I	Ida. . . .	266.4	16.15	II	Ida. . . .	245.6	15.08
I	Hazena ..	280.3	17.92	II	Hazena ..	262.8	18.50
I	Hypatia .	430.9	27.15	II	Hypatia .	373.2	25.06
II	Lukie. . .	298.2	20.63	I	Lukie. . .	338.5	22.39
II	Susan. . .	381.4	27.74	I	Susan. . .	398.8	29.00
II	Ada . . . .	356.5	20.12	I	Ada . . . .	377.8	21.76
Total.	{ 6 cows, { 21 days, { Per cow { per day	2013.7	129.71	Total.	{ 6 cows, { 21 days, { Per cow { per day	1996.7	131.79
		<b>16.0</b>	<b>1.03</b>			<b>15.8</b>	<b>1.05</b>

The two rations were practically of equal value, whether judged by the amount of milk or of butter produced. During the entire period covered by the experiment and on both rations the average daily yield of butter exceeded one pound per cow.

Assuming that manure and skim milk balance the labor of caring for the cows and that butter is worth 25 cents per pound we have the following financial statement:

*Financial statement.*

	With vetch ration.	With bran ration.
Value of butter from 6 cows, 21 days.....	\$32.43	\$32.95
Cost of feed, 6 cows, 21 days.....	12.96	17.69
Cost of food per pound of butter, cents.....	.100	.134
Daily profit per cow, cents .....	.155	.121
Profit per pound of butter cents .....	.15	.116

By substituting vetch hay for wheat bran there was a saving of 2.4 cents, or 26 per cent on the cost of each pound of butter.

Not only does the vetch hay pay a profit when fed, as compared with wheat bran, but it affords an additional profit if produced at a lower cost than \$10 per ton.

To sum up the whole comparison: Practically as much butter and milk was afforded by 834.6 pounds of vetch hay actually consumed as by 890.4 pounds of wheat bran. Hence each pound of vetch hay consumed was slightly more effective than a pound of wheat bran.

If we charge the cows also with the small amount of vetch hay that was fed, but not consumed, we find that *a ton of vetch hay was equal to a ton of wheat bran when*

fed to dairy cows in the proportion employed in this experiment. Stated differently, vetch hay was worth \$20 per ton when wheat bran cost \$20 per ton.

Every one of the six cows produced butter at much less cost on the vetch than on the wheat bran ration.

The cost of food for one pound of butter was as follows:

	On vetch ration. Cents.	On bran ration, Cents.
Susan .....	8.3	11.1
Lukie .....	8.9	11.6
Hypatia .....	9.0	13.2
Hazena .....	9.9	11.6
Ada .....	11.6	14.8
Ida .....	13.9	21.0

#### COWPEA HAY VERSUS WHEAT BRAN.

This experiment extended from December 19, 1902, to March 6, 1903. In addition to the usual preparatory feeding there were two periods of 30 days each. The rations were at the proper time reversed, so that during one part of the experiment each lot of cows received cowpea hay and during another portion of the test each lot received wheat bran. The general plan was similar to that of the preceding experiment, but on account of the larger amount of cowpea hay rejected (averaging about one-sixth of that offered) it was considered necessary to supply larger amounts of cowpea hay than of wheat bran.

Foodstuffs were valued at the same price as the previous winter. Cotton seed hulls were priced at \$5 per ton and a fair quality of cowpea hay at \$10 per ton.

A basal ration was made up by weight as below and fed to every cow during the entire experiment:

$\frac{1}{4}$  cotton seed (raw).

$\frac{1}{8}$  wheat bran.

$\frac{1}{8}$  cotton seed meal.

$\frac{1}{2}$  cotton seed hulls.

Of this mixture each lot of cows received practically equal amounts. The average quantity of this basal ration consumed daily per cow while eating cowpea hay was 19.18 pounds, and when eating an extra amount of wheat bran 19.35 pounds of the basal ration was consumed. This amount contained practically 9.6 pounds of concentrated food and an equal amount of hulls.

In addition to the above, each cow received during one period of the experiment cowpea hay, the average daily consumption of which was 6.5 pounds per cow.

During another period each cow received wheat bran, the average daily consumption of which was 6.1 pounds per cow.

*Summary of daily ration per cow.*

	Cowpea hay ration.	Wheat bran ration.
Cowpea hay .....	6.5**	
Wheat bran .....		6.1
Concentrated food in basal ration ....	9.6	9.6*
Cotton seed hulls .....	9.6	9.6*
Total daily ration, average.....	25.7	25.3

\*Approximate. \*\*7.84 pounds cowpea hay offered.

The cows used were as follows :

Lot.		Breed.	Age years.	Days since calving.	Weight when test began.
I	Lukie .....	Jersey	4	95	752
I	Susan .....	Jersey	5	115	696
I	*Neura .....	Jersey	3	72	691
I	Average .....			<b>94</b>	<b>713</b>
II	Ada .....	Jersey	11	73	887
II	Hazena .....	Jersey	4	72	734
II	Hypatia .....	Jersey	7	56	848
II	Average .....			<b>67</b>	<b>806</b>

\*Heifer with first calf.

The amount of the basal ration, common to every cow, averaged practically the same for each lot, whether the additional food was cowpea hay or wheat bran.

Incidentally it was ascertained in this test that running the cowpea hay through a feed cutter, so as to chop it into lengths of about two inches did not decrease the proportion of hay rejected.

*Amount, kind, and cost of food eaten.*

		Pounds food in 30 days.		
Period (each 30 days )	Cow.	Wheat bran.	Cowpea hay eaten.	Basal.
I	Dec. 26 to Jan. 25:			
I	Lukie .....		166.2	642
I	Susan .....		197.5	642
I	Neura .....		149.5	604
II	Feb. 4 to March 6:			
II	Ada .....		223.5	542
II	Hazena .....		219.3	482.5
II	Hypatia .....		220	540.5
Total.	6 cows .....		*1176.0	3453.0
II	Lukie .....	202	.....	560
II	Susan .....	202	.....	559
II	Neura .....	202	.....	482
I	Ada .....	164.5	.....	643
I	Hazena .....	162	.....	606
I	Hypatia .....	164.5	.....	634.5
Total.	6 cows .....	1097	.....	3484.5

\*1411 pounds of cowpea hay offered and charged against the cows.

The amount of wheat bran consumed by six cows in 30 days, in addition to the basal ration, was 1,176 pounds. Adding also the portion of the hay which was unused, and which consisted of nearly worthless coarse stems, we must charge the cows with 1,411 pounds of cowpea hay. This has been done in the following table in calculating the cost of food required to make a pound of butter.

Including this wasted material, the average cost of food for one pound of butter were 12.3 cents with the cowpea ration, and 15.9 cents with the wheat bran ration. This is a difference of 3.58 cents per pound of butter, or a saving of 23 per cent. in the cost of food required to make a pound of butter due to the substitution of the cheaper cowpea hay for wheat bran costing \$20 per ton.

*Milk and butter in 30 days from nearly equal amounts of cowpea hay and wheat bran.*

Cowpea Ration.				Wheat Bran Ration.			
Period.	Cow.	Milk lbs.	Butter lbs.	Period.	Cow.	Milk lbs.	Butter lbs.
I	Lukie. . .	529.7	35.01	II	Lukie. . .	462.6	31.41
I	Susan. . .	611.7	43.87	II	Susan. . .	514.7	37.01
I	Neura. . .	399.1	28.11	II	Neura. . .	349.7	25.26
II	Ada . . .	585.6	33.95	I	Ada . . .	563.4	29.72
II	Hazena . .	471.1	32.61	I	Hazena . .	479.2	31.70
II	Hypatia . .	511.9	31.27	II	Hypatia . .	509.8	29.27
Total.	{ 6 cows, { 30 days. { Per cow { per day	3109.1	204.82	Total.	{ 6 cows, { 30 days. { Per cow { per day	2879.4	184.37
		<b>17.3</b>	<b>1.13</b>			<b>16.0</b>	<b>1.02</b>

In the yield of both milk and butter the cowpea ration was slightly superior.

In brief, the cows on the cowpea ration *consumed* 7 per cent. more of cowpea hay than the other lot did of wheat bran, but in return the former afforded 11 per cent. more butter than did the cows that received wheat bran. So that the portion of the cowpea hay that was actually eaten was slightly more valuable than an equal weight of wheat bran. However, including the sixth of the cowpea hay that was wasted, we find that a ton of wheat bran was equal in feeding value to 2,327 pounds of cowpea hay; a ton of cowpea hay was equal to 86 per cent. of a ton of wheat bran, or to 1,720 pounds of wheat bran.

In other words, when wheat bran cost \$20 per ton, cowpea hay in the barn was worth 86 per cent. of this amount, or \$17.20 per ton.

*Financial statement.*

	With cow- pea ration.	With bran ration.
Value of butter from 6 cows, 30 days .....	\$51.21	\$46.09
Cost of food (6 cows, 30 days), eaten.....	25.18	29.29
Profit from 6 cows, 30 days .....	26.03	16.80
Cost of food per pound of butter .....	0.123	0.159
Daily profit, per cow .....	0.145	0.090
Profit per pound of butter .....	0.127	0.091

Assuming that the value of the manure will pay for labor and that skim milk and the production of a calf will meet other charges, we have a monthly net profit per cow of \$4.35 per month when a cowpea ration was fed.

The substitution of cowpea hay for wheat bran effected a saving of 23 per cent. in the cost of producing a pound of butter when wheat bran was rated at twice the price of cowpea hay.

In this experiment, as in the one made the previous winter, every cow produced butter at much cheaper cost when consuming large amounts of nitrogenous hay. Susan again afforded the cheapest butter, costing for food per pound of butter 10.4 cents when hay was fed.

The cost of food per pound of butter was as follows:

	With cowpea ration.	With bran ration.
Susan .....	10.4	13.3
Hazena .....	11.8	15.1
Lukie .....	12.2	15.8
Ada .....	12.3	17.0
Hypatia .....	13.3	17.0
Neura .....	14.5	18.0



## LIMITATIONS TO THE SUBSTITUTION OF HAY FOR WHEAT BRAN.

Viewing the results of the two preceding experiments together it is evident that the hay of hairy vetch is quite as valuable as an equal weight of wheat bran, and that a good quality of cowpea hay is worth 86 per cent. as much as wheat bran.

This would probably not be true if we endeavored to support a cow in full flow of milk on hay alone, or almost entirely on hay. These tests showed that in rations containing 6 to 10 pounds of concentrated food (cotton seed, wheat bran, etc.,) about 6.5 pounds of hay of vetch or cowpea was practically as effective as, and much more economical than, wheat bran. In future tests we hope to ascertain whether still larger amounts of leguminous hay can be substituted for corresponding quantities of wheat bran.

Readers are cautioned against assuming that equally favorable results would be obtained by the substitution of limited amounts of grass hay for wheat bran. The hay of vetch, cowpeas, crimson cover, red clover, and alfalfa is quite similar in composition to wheat bran and much richer in nitrogenous material than hay made from the grasses. These leguminous plants just mentioned, being rich in nitrogen, make not only rich food, but rich manure.

Not least among the considerations which should impel the dairyman to displace wheat bran as far as practicable with foods grown on the farm is the possibility that the wheat bran which he buys may be adulterated, even to the extent of being made up of 30 per cent. ground corn cobs.

Still stronger reasons for supplanting wheat bran by leguminous hay are the reduced cost of butter and the

improvement in the soil where even the stubble of cow-peas, vetch, or other leguminous plants have grown.

#### AMOUNT OF FOOD PER POUND OF BUTTER.

Since the cost of food fluctuates so widely from year to year, we may with profit reduce the data obtained in both the preceding experiments to a more stable basis by calculating the amount of air-dry food required per pound of butter produced.

##### *Air dry food per pound of butter.*

	Hay ration. Lbs.	Bran ration. Lbs.
1901-2.		
Vetch hay eaten and wasted.....	6.82	
Vetch hay or bran consumed .....	6.43	6.76
Basal ration .....	10.84	10.67
	<hr/>	<hr/>
Total food consumed .....	17.27	17.43
1902-3.		
Cowpea hay eaten and (16 per cent.) wasted .....	6.88	
Cowpea hay or wheat bran consumed	5.74	5.95
Basal ration ( $\frac{1}{2}$ concentrated food..)	16.86	18.19
	<hr/>	<hr/>
Total food consumed .....	22.60	24.14

Five of the cows were used in the experiments of both winters. Each of them required a larger total amount of food for the second winter, chiefly because the basal ration at that time contained a large amount of cotton seed hulls, a material having very low nutritive value.

*The effects of the rations on the live weights of the cows.*

On vetch hay the cows remained practically stationary in weight, while under the same conditions the average gain per cow per period was 13 pounds when wheat bran was fed.

The next winter the cows on cowpea hay gained only 1 pound per head per period, while those getting wheat bran grew heavier by  $16\frac{1}{2}$  pounds per head.

This suggests a slightly greater tendency of wheat bran than of hay of vetch or cowpeas to increase the live weight, a doubtful advantage in the case of the milch cow.

#### MINOR TESTS.

At the conclusion of the experiments just described the feeding season was too nearly past and the cows too far advanced in lactation to permit any further experiments requiring long periods. Hence in the two experiments described below it was necessary to adopt the short period sometimes employed, dividing each experiment into three periods and using the data only for the last ten days of each period, the earlier part of the period being considered as preparatory. The natural shrinkage in the flow of milk was counterbalanced by averaging the results of the first and third periods, during which the same food was fed, and comparing this average with the yield of milk and butter obtained during the second or intermediate period.

The ration fed during the first and third period of this experiment was the same as that fed to the corresponding lot of cows during the second period of the experiment previously described. The same six cows were employed. The basal ration was the same as in the experiment comparing cowpeas with wheat bran.

### CORN HEARTS COMPARED WITH WHEAT BRAN.

For 7 pounds of wheat bran per head daily was substituted 6.8 pounds of corn hearts, a by-product from corn obtained in the manufacture of grits or hominy. Our supply came from the Western Grain Company, Birmingham, Ala., and cost, in Birmingham, \$24.00 per ton in February, 1903.

One cow failed to eat the corn hearts as freely as wheat bran.

#### *Corn hearts vs. wheat bran.*

Perioe.	Ration.	Milk lbs. 3 cows, 10 days.	Butter lbs. 3 cows, 10 days.
I	Wheat bran .....	474.2	31.9
III	Wheat bran .....	449.5	28.9
	Average .....	461.8	30.4
II	Corn hearts .....	495.6	33.0
	Difference in favor of corn hearts..	33.8	2.6

Evidently corn hearts was a better food than wheat bran. The increase with the corn hearts ration as compared with the bran ration was 8 per cent. in butter, and 7 per cent. in milk.

The basal ration consisted of the same materials as in earlier experiments,—cotton seed and cotton seed hulls, with a small proportion of both cotton seed meal and wheat bran.

In these tests corn hearts was worth as a food for production of butter \$21.60 per ton, when wheat bran was worth \$20.

### SOY BEAN HAY COMPARED WITH COWPEA HAY.

In addition to the basal ration, which was the same for both lots, soy bean hay was consumed at the rate of 6.6 pounds per cow daily, or cowpea hay at the rate of 7 pounds daily.

In addition to the above amount actually consumed, 32 per cent. of the soy bean hay that was offered was rejected. This rejected portion consisted of the coarse stalks and some of the larger limbs. The corresponding waste with cowpea hay in this test was 22 per cent. of that offered.

*Soy bean hay vs. cowpea hay.*

Period.	Ration.	Milk lbs.	Butter lbs.
I	Cowpea hay .....	545.7	34.60
III	Cowpea hay .....	487.2	30.11
	Average .....	516.4	31.85
II	Soy bean hay .....	535.3	33.25
	Difference in favor of soy bean hay	18.9	1.4

From the above table we see that the soy beans afforded  $4\frac{1}{2}$  per cent. more butter and  $3\frac{1}{2}$  per cent. more milk than an equal weight of cowpea hay actually consumed. However, the greater waste or greater residue with the soy bean fully counterbalances this, reducing the hay of these two valuable leguminous plants to a practical equality in feeding value. Soy beans are worthy of more extensive cultivation in the South. Their principal advantage over cowpeas consists in their easier curing, erect growth, and freedom from tangling. In our experiments they seem to require slightly richer soil than cowpeas.

**DIGESTIBLE MATTER IN RATIONS FED.**

In the following table are given the amounts in the daily rations fed of digestible dry matter; protein, or "muscle formers"; carbohydrates (chiefly starchy material); and fat. For comparison, the table also includes the figures showing what is generally regarded as the normal nutritive requirement of a cow in full flow of milk.

*Digestible nutriments in rations fed.*

Ration.	Dry matter.	Digestible nutriments.			Nutritive ratio.
		Protein.	Carbohydrates.	Fat.	
Wolff-Lehmann Standard .....	Lbs. 29	Lbs. 2.5	Lbs. 13	Lbs. .5	Lbs. 1:5.7
11.8 lbs. vetch hay .....	} 15.80	2.26	7.58	.91	1:41
4.0 lbs. cotton seed.....					
2.0 lbs. wheat bran.....					
17.8 lbs. total .....					
9.0 lbs. wheat bran .....	} 16.119	2.277	7.009	.998	1:40
4.0 lbs. cotton seed hulls...					
5.2 lbs. vetch hay.....					
18.2 lbs. total .....					
6.5 lbs. cowpea hay.....	} 22.92	2.51	8.47	1.42	1:4.6
9.6 lbs. cotton seed hulls...					
4.8 lbs. cottonseed .....					
2.4 lbs. cottonseed meal.....					
2.4 lbs. wheat bran .....					
25.7 lbs. total .....					
6.1 lbs. wheat bran .....	} 22.51	2.55	8.35	1.51	1:4.6
2.4 lbs. wheat bran.....					
9.6 lbs. cottonseed hulls...					
4.8 lbs. cottonseed .....					
2.4 lbs. cottonseed meal.....					
25.3 lbs. total .....					
9.2 lbs. wheat bran .....	} 21.59	2.50	8.11	1.40	1:4.5
8.6 lbs. cottonseed hulls...					
4.3 lbs. cottonseed .....					
2.2 lbs. cottonseed meal.....					
24.3 lbs. total .....					
6.8 lbs. corn hearts .....	} 20.62	2.35	7.77	1.33	1:4.3
2.1 lbs. wheat bran.....					
8.2 lbs. cottonseed hulls...					
4.1 lbs. cottonseed .....					
2.0 lbs. cottonseed meal.....					
23.2 lbs. total .....					

Ration.	Dry matter.	Digestible nutrients.			Nutritive ratio.
		Protein.	Carbohydrates.	Fat.	
7 lbs. cowpea hay.....	21.69	2.40	8.07	1.27	1:4.4
2.2 lbs. wheat bran .....					
8.6 lbs. cottonseed hulls....					
4.3 lbs. cottonseed .....					
2.2 lbs. cottonseed meal....					
24.3 lbs. total .....					
6.6 lbs. soy bean hay.....	21.28	2.36	7.92	1.31	1:4.6
2.2 lbs. wheat bran.....					
8.6 lbs. cottonseed hulls....					
4.3 lbs. cottonseed .....					
2.2 lbs. cottonseed meal....					
23.9 lbs. total .....					

All of these rations fall far below the German standard in carbohydrates, and greatly exceed it in fat. In the Gulf States, by reason of the high price of corn, it is customary to feed rations which present much the same departures as above from the standard considered desirable in countries where carbohydrates are cheap. In spite of the large amount of fat, no digestive disorders resulted.

#### AMOUNT OF MANURE PRODUCED BY DAIRY COWS.

The manure dropped in the barn during ten nights by three cows was weighed for the period from January 17 to 26th, 1903. At this time this lot of cows was getting the cowpea ration. They were in the stable about 16 hours per night.

During this time the average amount of solid and liquid manure per cow per night was 36.1 pounds, exclusive of rye straw bedding, which was 4 pounds per night. Hence the total amount of manure was 40.1 pounds per night for cows averaging 713 pounds in live weight. This is at the rate of 1,203 pounds of manure dropped in the barn per month for each Jersey cow milked.

Again the manure collected by stabling the cows at night, March 26th to 30th, was weighed, one lot of cows then getting the cowpea ration, the other the wheat bran ration. The average daily production of liquid and solid manure, free from bedding, was 28.3 pounds, or, including fine straw bedding, 29.6 pounds, or 888 pounds per cow per month.

During the next five days the six cows were kept in the stable continuously, except for the few minutes required twice daily for watering, at which time they were watched to see that no manure was lost. The ration was the same as during the preceding five days, three cows receiving the cowpea hay ration and three the wheat bran ration.

Under these conditions of continuous stabling the average daily production of manure was 56.8, exclusive of bedding; the total, including pine straw bedding, was 58.3 pounds. Comparing these amounts, we find that 50 per cent. of the net manure was dropped during eight hours out of doors and an equal amount during sixteen hours in the barn. This is in close agreement with previous tests made at this station and recorded in Bulletin No. 114:

“This 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.”

This is equivalent to a production of 1,749 pounds of manure per cow per month, including bedding, or to three and one-half tons during a stabling period of four months, half of which (dropped in the barn), and a part of that dropped in the lot, would be saved.

It is of interest to note that during the time covered by these tests each pound of dry food consumed resulted in the production of about two and one-half pounds of manure.