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AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

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DIVISION OF ANIMAL INDUSTRY

DAIRY CATTLE FEEDING EXPERIMENTS

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*In cooperation with the School of Veterinary Medicine, A. & M. College of Texas.
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CONTENTS.

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BULLETIN NO. 238. NOVEMBER, 1918.

DAIRY CATTLE FEEDING EXPERIMENTS

BY

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This report covers two experiments in dairy cattle feeding conducted during the spring of 1918. They were calculated to answer questions pertaining to feeding value for milk production of important Texas feedstuffs. Cottonseed meal is, of course, the most commonly used protein concentrate for dairy cows and is hence in many instances used as a standard by which to compare the milk-producing value of feeds to be tested. The peanut feed used was the ground pressed peanuts, which had a part of the hulls removed. Peanut products are coming rapidly into more general use as feed because of a rapidly increasing production of peanuts. Velvet beans constitute a new dairy cattle feed of growing importance. While only the eastern and coastal regions of the State are adapted for velvet bean production, the beans are being used extensively in all sections where feeding stuff must be imported. Part I of this report covers a feeding experiment in which peanut feed was used, while Part II involves the question of the most suitable method of preparation of whole velvet beans for dairy cattle feeding.

PART I.

COTTONSEED MEAL VS. PEANUT FEED FOR MILK PRODUCTION.

The object of these tests was to compare the relative values of peanut feed and cottonseed meal for milk and butter fat production. In addition to the factors of production, observations were made on questions of palatability and general suitability of the feed used for dairy cows.

Eighteen selected cows were divided into three lots of six cows each, care being taken to divide them as equally as possible with respect to age, production, size, feeding capacity, stage of lactation, and natural productive capacity.

Table 1 shows the division and condition of the cows used in these tests.

These cows were all treated alike in regard to pasture and basal rations and the only variable permitted was in the case of the protein supplements fed. Since the conclusions were to be based upon results by lots, the lots were balanced so far as total feed consumption was con-

*In cooperation with School of Agriculture, Agricultural and Mechanical College of Texas.

Table 1.—Condition of cows in experiment.

	Cow No.	At the beginning		At the close	
		Days in lactation	Average weight	Average weight	Days in gestation
Lot 1	1	15	840	868	.....
	28	222	760	830	222
	42	23	507	582	.....
	54	29	575	635	.....
	77	102	625	740	.....
	78	101	517	598	55
Average	.....	82	637	709	
Lot 2	10	144	665	745	100
	26	181	710	718	69
	27	99	723	790	.....
	31	88	615	682	.....
	61	52	370	448	.....
	76	43	747	825	.....
Average	.....	101	631	701	
Lot 3	6	16	830	820	.....
	22	191	880	953	.....
	24	10	625	622	.....
	34	195	505	603	121
	46	70	480	557	37
	48	185	753	838	166
Average	.....	111	679	732	

cerned, and the individual cows of each lot were fed according to feeding capacity and production. The test covered a period of twelve weeks divided into four equal periods of three weeks each. The feeding scheme shown in table 2 indicates the feeding plan. Lots 1 and 2 alternated on cottonseed meal and peanut feed as the protein concentrates, while lot 3 acted as a check lot and was fed a mixture of cottonseed meal and peanut feed in the same proportion as to the other lots through the entire period. At the end of each period the feed was shifted abruptly in the afternoon and the records began on the next period the following morning. This was done to secure information on the relative palatabilities of the feeds. No cow ever refused her feed and both the peanut feed and the cottonseed meal were relished at all times. There were indications that the cows would not have taken as much cottonseed meal as they did of peanut feed. This method of changing feed abruptly is a disadvantage to the better feed, which loses credit for the good condition of the cows at the end of a period and receives them in poor condition at the beginning of a period.

The rations used were designated as A, B, and C, the rations containing peanut feed, cottonseed meal and the mixture of the two respectively. During this test the cows ran throughout the day on the best pasture available and had access at night to all of the wheat straw they would clean up. From April 14 to May 18 they were on different plats of oats, wheat, barley, and rye. Until July 1 they ran in a wood pasture of native grasses and towards the close of the experiment they were on a Sudan pasture. Lot 3 was used as a check on the effects of the changes resulting from the method of feeding. The concentrate mixtures fed in the barn at milking time were made up as follows:

Ration A. 100 lbs. corn chops
100 lbs. peanut feed
1½ lbs. salt

Ration B. 300 lbs. corn chops
200 lbs. cottonseed meal
3 lbs. salt

Ration C. 600 lbs. corn chops
300 lbs. peanut feed
200 lbs. cottonseed meal
7 lbs. salt

Chemical analyses of composite samples of the two feeds used gave the following results:

	Peanut feed	Cottonseed meal
Protein	38.19	42.38
Fat	8.46	7.98
Crude fiber	11.54	11.31
Nitrogen-free extract	27.61	25.95
Water	6.19	7.26
Ash	8.01	5.12

Henry and Morrison give the digestible nutrients of peanut cake with hulls as 58.7 per cent., with a nutritive ratio of 1:1.9, while the total digestible nutrient of cottonseed meal amounts to 78.2 per cent., with a nutritive ratio of 1:1.1. This would give peanut feed a value a little more than two-thirds that of cottonseed meal. These feeds were, therefore, fed in the proportion of three to two. Comparison of the analyses of the peanut feed with the average analyses given by Henry and Morrison, shows the peanut feed used to be intermediate between pure peanut meal and ground whole-pressed peanuts. If it is assumed that it is intermediate also in digestibility, it is found to contain approximately 69.0 per cent. of digestible nutrients with a nutritive ratio of 1 to 1.4. The results secured in this test indicate that these figures come most nearly to expressing its true value.

It may be noted that the concentrated mixtures fed have a nutritive ratio of approximately 1 to 3. This seems at first to be very narrow, but when it is considered that the feeds obtained in the pasture were practically all rich in carbohydrates, it will be seen that the total rations were no narrower than are justified by Texas conditions, where protein is generally cheaper than carbohydrates. It would appear that the proper basis of comparison of feeds for our conditions would be the total percentage of digestible nutrients rather than the percentage or proportion of protein. In order to compare the relative values of the protein in two feeds, it would be necessary to feed them in a ration which would have a nutritive ratio as wide as the feeding standards advise. Such a ration would be unnecessarily expensive and impractical under Texas conditions.

Table 2.—Feeding plan employed.

	Period 1	Period 2	Period 3	Period 4
Lot 1	B	A	B	A
Lot 2	A	B	A	B
Lot 3	C	C	C	C

Following out this general feeding plan, each cow's milk was weighed at each milking and a weekly composite sample was made up from the

individual milkings on which butter fat tests were made. In addition to production records feed records were kept and from these the figures in table 3 have been calculated.

Table 3.—Results of the experiment.

Period	Daily production record				Daily feed record in pounds.		
	Ration	Milk, lbs.	Test per cent	Fat, lbs.	Corn chops	P. N. feed	C. S. meal
Lot 1							
1.....	B	15.32	4.35	0.666	2.88	.....	1.92
2.....	A	13.72	4.61	0.632	3.14	3.14	.....
3.....	B	14.41	4.51	0.649	3.21	.....	2.14
4.....	A	13.97	4.30	0.601	3.22	3.22	.....
Lot 2							
1.....	A	14.79	4.53	0.669	2.88	2.88	.....
2.....	B	13.04	4.72	0.615	3.14	.....	2.09
3.....	A	13.95	4.74	0.662	3.22	3.22	.....
4.....	B	12.45	4.60	0.573	3.22	.....	2.14
Lot 3							
1.....	C	15.88	4.18	0.664	2.88	1.44	.96
2.....	C	14.28	4.32	0.617	3.14	1.57	1.05
3.....	C	15.03	4.33	0.651	3.22	1.66	1.07
4.....	C	14.01	4.14	0.580	3.22	1.66	1.07

From table 3 can be secured comparative figures on production for the feeds being tested. Condensing the results given in table 3, the results given in table 4 are secured.

Table 4.—Results of experiment in condensed form.

Ration	Production record.			Feed record.		
	Milk, lbs.	Test	Fat, lbs.	Corn chops	P. N. feed	C. S. meal
A	8297.8	4.55	377.11	1831.5	1831.5	.....
B	8119.1	4.52	368.26	1831.4	.....	1221.6
C	8702.9	4.24	369.34	1830.7	915.2	610.1

From these results, it is seen that ration A, the peanut feed ration, produced 178.7 pounds or 21 gallons more milk and 8.85 pounds more fat than ration B, the cottonseed meal ration. As is noted later, this increased production was not justified by the increased cost of production. It may also be noted that ration C produced 583.1 pounds, or 68 gallons more milk and 1.08 pounds more fat than ration B. The same superiority of ration A over ration B is shown by comparing the production of each lot by periods when the production of each period is expressed as a percentage of the production of the same lot in the previous period. These percentages are shown in table 5 as follows:

Table 5.—Percentage changes in milk production due to changes in ration.

	Lot 1		Lot 2		Lot 3	
	Ration	Change	Ration	Change	Ration	Change
Periods 1 to 2.....	B to A	89.5	A to B	88.2	C to C	89.9
Periods 2 to 3.....	A to B	105.0	B to A	107.0	C to C	105.3
Periods 3 to 4.....	B to A	97.0	A to B	89.2	C to C	93.1

From these figures it is found that the average change resulting from the change of ration A to B amounts to 94.1 per cent. When the change is from ration B to A the average percentage change is 97.8. On this basis, ration A appears to be superior to ration B.

The cottonseed meal used in these tests was purchased in November, 1917, and cost, delivered, $2.93 per hundredweight. The peanut feed was bought in March, 1918, and cost $2.96 per hundredweight. It should be noted that the two feeds cost approximately the same, with the peanut feed costing but three cents more per hundred than the cottonseed meal. As previously noted, the cows on ration A produced 21 gallons more milk and 8.85 pounds more fat than when fed on ration B, the increased cost of ration A over ration B being $18.43, or 88 cents per gallon of milk and $2.07 per pound of fat. The cows of lot 3 on ration C produced 68 gallons more milk and 1.08 pounds more fat than the cows on ration B at a greater cost of $9.18, the increased milk costing 13.5 cents per gallon. From these figures, it appears that the greatest economy of production came from ration C containing both cottonseed meal and peanut feed. This is in accord with previous work* with cocoanut meal, where a mixture of cottonseed meal and cocoanut meal was found to give greatest yield and economy of production.

In studying the results of this test, note should be made from table 1 that lot 1 gained in weight during the experiment an average of 72 pounds per cow, while lot 2 gained an average of 70 pounds per cow. Considering the condition of the cows at the beginning of the test, some gain in weight was desirable but it is not possible to tell how much feed was required for these gains.

Conclusions.

The results of this test indicate that

1. This commercial peanut feed did not prove quite so valuable for milk and butter fat production pound for pound as the cottonseed meal.
2. The most economical ration fed was the one containing both cottonseed meal and peanut feed in the proportion of two to three, when both feeds cost approximately the same.
3. Under most conditions in the State total digestible nutrients offer a better method of comparing feeds for dairy cows than does the protein content.
4. There were evidences of some differences in the palatabilities of the rations. Ration C, containing both peanut feed and cottonseed meal, proved most palatable, while ration A, containing peanut meal, was more palatable than ration B, containing the cottonseed meal.

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*Bulletin 225, Texas Agricultural Experiment Station.

PART II.

COMPARISON OF METHODS OF PREPARATION OF VELVET BEANS FOR DAIRY COWS.

The velvet bean is comparatively a new crop which in two or three years has attained great prominence in all the southeastern and gulf States. There are many varieties of velvet beans, which vary a great deal in amount of foliage, yield of beans, and other habits of growth. Among the chief varieties are the Early Speckled, Florida, Yokahoma, Chinese, Lyon, Osceola, and Georgia. Of these the Early Speckled is the most generally grown and was the kind used in the experiment herein reported. Nearly all velvet beans are grown in connection with corn, corn being planted as early as possible and the velvet beans being planted as soon as all danger of frost has passed. The beans are either planted in alternate rows with corn or planted in the same rows. In either case, the corn acts as a support for the beans. Velvet beans do very well on even the poorest soils. While they secure an abundance of nitrogen from the air, they frequently require some mineral fertilizers in order to secure a maximum yield.

It should be borne in mind, however, that the velvet bean is a subtropical plant, adapted only to conditions of abundant moisture. Experiments have shown that it cannot safely be planted in other than the extreme southeast portion of the State. In East Texas it should be planted only on the advice and under the supervision of the county agent.

While the most common practice of feeding is to turn cattle and hogs in the field to graze off the crops, the practice has grown of handpicking the best of the beans before the stock are turned in and of using these picked beans in the hulls for feeding purposes. The beans as they come from the field are readily eaten by the cattle. They are, of course, nitrogenous in nature and it has been found that they can be fed in indefinite quantities to cows without injury. Their high feeding value has created a great demand in those sections where a lack of feed, especially protein concentrates, prevails. The advantages of crushing the beans because of greater economy in shipping and storage soon became quite apparent, and certain difficulties were met with in the grinding of velvet beans which necessitated special grinding machinery. While probably most of the velvet beans have been shipped out as velvet bean feed, which is composed of the ground whole beans, large quantities have also been shipped of the unground beans in the bulk. These beans, in many instances, have constituted a new feed in the localities where they have been shipped in, which has given rise to questions concerning the best methods of preparation of beans for feeding purposes. Because of the demand for information along this line, this Station undertook to conduct some feeding experiments with velvet beans with the following objects in view: First, to compare the influence of methods of preparation of velvet beans on milk and butter fat production; second, to study the influence of methods of preparation of velvet beans on palatability; third, to study the influence of methods of preparation of velvet beans on economy of production.

For this work twelve cows were selected and divided into four lots. After giving due consideration to the size of the cows, their productive capacity, period of lactation, previous feeding, and other factors, they were divided into four lots. Each lot of three head was then fed through four periods of twenty days each on daily rations made up as follows:

Ration A	Pasture	Corn bran 4 parts	C. S. meal 2 parts	Whole velvet beans 6 parts
Ration B	"	"	"	Cracked velvet beans 6 parts
Ration C	"	"	"	Cracked and soaked velvet beans, 6 parts
Ration D	"	"	"	Ground velvet beans, 6 parts

No record was kept of the amount of feed which the cows consumed on pasture. The pasture was at least average in quantity and quality and was a common Texas woods pasture. The corn bran and cottonseed meal were fed in the quantities indicated above as the basal concentrates, while the velvet bean feed was fed at the rate of six pounds per head per day, and the variable was constituted by the method of preparation of this six pounds of velvet beans as indicated in the rations given above.

The feeding schedule employed was according to the following:

	Periods			
Lots	1	2	3	4
1	A	B	C	D
2	C	D	A	B
3	D	A	B	C
4	B	C	D	A

For reference, the following average analyses* of the feeds used is herewith given:

Table 1.—Average analyses* of concentrates used.

	Crude protein	Crude fat	Crude fiber	Nitrogen-free extract	Water	Ash
Corn bran	9.82	7.03	10.79	59.31	10.63	2.42
Cottonseed meal	43.55	7.86	10.23	26.29	6.73	5.34
Velvet bean feed	17.21	4.44	14.26	49.90	9.50	4.69

*Supplied by Texas Feed Control Service.

The analyses of the concentrates used indicated that they were adequate to supply the requisite quantities of digestible crude protein and total digestible nutrients. The experiment was run so that there were four five-day periods in each of the twenty-day periods. At the end of each five-day period a complete report was made of the total feeds consumed, total milk production, average butter-fat percentage from composite samples, and pounds of butter-fat production. In addition, notes were made on relative palatabilities of the rations used. From these reports we are enabled to calculate the results of the experiments as shown in tables 2, 3, 4, and 5 as follows:

Table 2.—Showing feeds consumed and milk and butter-fat production on the several rations by five-day periods for period 1.

	Corn bran	C. S. meal	Velvet beans	Milk	Test	Fat
Period 1a						
Ration A	60	30	80½	507.5	3.35	17.043
Ration C	60	30	90	460.2	3.4	15.845
Ration D	60	30	89	540.3	3.2	17.447
Ration B	60	30	89½	483.1	3.6	17.233
Period 1b						
Ration A	60	30	100	495.0	3.3	16.120
Ration C	60	30	90	433.5	3.2	13.997
Ration D	60	30	90	491.6	2.9	14.075
Ration B	60	30	90	439.2	3.4	15.104
Period 1c						
Ration A	60	30	90	473.7	3.4	16.298
Ration C	60	30	90	405.5	3.5	14.329
Ration D	60	30	90	488.8	3.2	15.398
Ration B	60	30	90	434.0	2.7	15.863
Period 1d						
Ration A	60	30	90	512.5	2.9	14.702
Ration C	60	30	90	466.6	3.0	14.198
Ration D	60	30	90	510.2	3.0	15.400
Ration B	60	30	90	457.5	3.2	14.456

Table 3.—Showing feeds consumed and milk and butter-fat production on the several rations by five-day periods for period 2.

	Corn bran	C S. meal	Velvet beans	Milk	Test	Fat
Period 2a						
Ration B	60	30	90	495.8	2.7	13.297
Ration D	60	30	90	460.5	2.8	12.782
Ration A	60	30	90	499.8	2.8	14.220
Ration C	60	30	90	459.9	3.1	14.013
Period 2b						
Ration B	60	30	90	458.6	3.0	13.674
Ration D	60	30	90	449.5	2.9	13.068
Ration A	60	30	90	457.9	3.0	13.720
Ration C	60	30	90	451.7	3.2	14.407
Period 2c						
Ration B	60	30	90	427.2	3.4	14.221
Ration D	60	30	90	421.3	3.0	12.759
Ration A	60	30	90	449.2	3.2	14.388
Ration C	60	30	90	411.6	3.2	13.280
Period 2d						
Ration B	60	30	90	400.5	2.9	11.729
Ration D	60	30	90	368.0	3.0	11.140
Ration A	60	30	90	398.6	3.2	12.802
Ration C	60	30	90	388.9	3.4	13.360

Table 4.—Showing feeds consumed and milk and butter-fat production on the several rations by five-day periods for period 3.

	Corn bran	C. S. meal	Velvet beans	Milk	Test	Fat
Period 3a						
Ration C	60	30	90	418.2	3.1	12.605
Ration A	60	30	90	383.2	2.9	11.060
Ration B	60	30	90	402.5	3.1	12.594
Ration D	60	30	90	379.3	3.4	12.814
Period 3b						
Ration C	60	30	90	396.3	3.2	12.816
Ration A	60	30	90	350.9	2.9	10.318
Ration B	60	30	90	401.4	2.9	11.901
Ration D	60	30	90	375.1	3.4	12.659
Period 3c						
Ration C	60	30	90	400.3	3.5	13.815
Ration A	60	30	90	347.2	3.5	12.289
Ration B	60	30	90	391.1	3.3	12.880
Ration D	60	30	90	399.8	3.5	13.854
Period 3d						
Ration C	60	30	90	382.5	3.4	12.915
Ration A	60	30	90	333.8	3.5	11.473
Ration B	60	30	60	370.6	3.2	12.087
Ration D	60	30	90	352.0	3.6	12.676

Table 5.—Showing feeds consumed and milk and butter-fat production on the several rations by five-day periods for period 4.

	Corn bran	C. S. meal	Velvet beans	Milk	Test	Fat
Period 4a						
Ration D	60	30	90	365.0	3.1	11.146
Ration B	60	30	90	302.5	3.1	9.450
Ration C	60	30	90	326.3	3.4	11.082
Ration A	60	30	90	308.0	3.8	11.651
Period 4b						
Ration D	60	30	90	341.3	3.4	11.797
Ration B	60	30	90	288.0	3.4	9.225
Ration C	60	30	90	331.6	3.5	11.483
Ration A	60	30	90	282.1	3.4	9.601
Period 4c						
Ration D	60	30	90	360.5	3.5	12.600
Ration B	60	30	90	296.1	3.4	9.981
Ration C	60	30	90	324.4	3.5	11.265
Ration A	60	30	90	267.1	3.4	9.149
Period 4d						
Ration D	60	30	90	386.9	3.4	13.137
Ration B	60	30	90	297.2	3.5	10.458
Ration C	60	30	90	340.9	3.5	11.823
Ration A	60	30	90	270.2	3.7	9.912

From tables 2, 3, 4 and 5, it is possible to construct table 6, which offers a direct method of comparison of the yields of milk and butter-fat on the basis of method of preparation of the beans.

Table 6.—Showing feeds consumed and milk and butter-fat produced on the four rations being compared.

	Corn bran	C. S. meal	Velvet beans	Milk	Test	Fat
Ration A	960	480	1440½	6,336.7	3.23	204.746
Ration B	960	480	1439½	6,345.3	3.22	204.153
Ration C	960	480	1440	6,398.4	3.30	211.233
Ration D	960	480	1440	6,690.1	3.18	212.752

From the standpoint of production, several points of interest are to be noted from table 6. So far as milk production is concerned, it should be noted that the mere cracking of the beans was not justified by the increased yield which for 1440 pounds of beans amounted to but 1 gallon of milk. The increase over whole beans was only .13 per cent. At 40 cents per gallon, one ton of beans cracked would be worth but about 55 cents more than whole beans. Since it is practically impossible to handle and crush or crack beans at these figures, it is safe to assume that in this case it did not pay to merely crack the beans. It was found that by cracking and soaking, an increased yield of 0.96 per cent. or 7.2 gallons for 1440 pounds was secured. This would be at the rate of 10 gallons increased production per ton of cracked soaked beans. At 40 cents per gallon this would make the additional value of milk secured as a result of cracking and soaking $4.00 per ton. If the beans could be cracked and soaked for less than this figure per ton the operation would be profitable. Under most conditions it could not be done for this figure and would usually not be found justifiable. The extra labor and trouble involved, not only in the cracking, but in the soaking, would not be justified. When the beans are ground an in-

creased production of 5.57 per cent or 41 gallons per 1440 pounds or 57 gallons per ton was secured, which is worth $22.80 at 40 cents per gallon. Since regular feed mills ordinarily grind at a cost of $2.50 to $3.00 per ton and since on most farms where the equiment is available the cost does not usually exceed $5.00 per ton, it is quite evident that the grinding of velvet beans for cows is quite a profitable operation.

So far as the butter-fat production is concerned, at least similar results were secured. The cracking resulted in a fraction of a pound production decrease, which is negligible. The cracking and soaking yielded an increased milk production of 3.14 per cent. or 6½ pounds for 1440 pounds of beans. At 50 cents per pound this would be worth but $3.25, which would, as has been noted, not justify the extra labor and trouble involved. When one comes to the grinding, there is found an increased production of 3.98, or practically 4 per cent. due to the grinding. For 1440 pounds the milk increase was 8 pounds, which for one ton would amount to 11.1 pounds. At 50 cents per pound this would amount to $5.55, which, as previously noted, would be justified. Yet the increased production of fat is not so marked as the increased milk production.

When one considers the percentage of butter fat, there are no wide variations. The difference on all the rations is within a range of 0.12 per cent. With the increased milk production where the beans were ground, there naturally occurs the lowest percentage of butter-fat.

One of the objects of this test was to ascertain the influence of method of preparation of the beans on palatability. Careful observation through the period of the experiment showed that the method of preparation apparently exerted no influence on palatability. When first started on the experiment, several of the cows at first refused to eat all of their feed, but cows on all the rations left some feed. After they became accustomed to the beans, which were a new feed to them, they ate the full amount with relish. The method of preparation therefore seemed to exert no influence on the palatability.

Conclusions.

As a result of these tests the following conclusions seem justified:

1. Extra preparation of the velvet beans always resulted in increased milk production.
2. Cracking and soaking and grinding of the beans always resulted in increased butter-fat production.
3. Cracking of the beans alone was not justified from the standpoint of increased production.
4. Cracking and soaking had a doubtful value when considered from the standpoint of increased production of milk and butter-fat.
5. Grinding proved very profitable from the standpoint of increased milk production and was justified by increased butter-fat production.
6. The method of preparation exerted no apparent influence on palatability.