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# TEXAS AGRICULTURAL EXPERIMENT STATION

B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 352 MARCH, 1927



DIVISION OF DAIRY HUSBANDRY

# RICE BRAN AS A FEED FOR DAIRY COWS

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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†As of January 1, 1927.
*On Leave.
**Dean, School of Veterinary Medicine.
***In cooperation with U. S. Department of Agriculture
****In cooperation with the School of Agriculture.

## SYNOPSIS

This Bulletin contains a general description of rice bran and a short review of the published experiments about its use as a feed for farm animals. A report is given of the findings obtained in three experiments with dairy cows at Substation No. 10 of the Texas Agricultural Experiment Station. Some of the cows seemed to dislike the grain rations containing rice bran even when they contained as little as 36 per cent of rice bran. When good green pasture was available all cows refused a larger proportion of the rice bran ration than of the ration which did not contain rice bran. In spite of its lower palatability, rice bran proved to be a very useful feed for dairy cows. Even a heavy ration of rice bran produced no bad effects on the flavor of the milk. The use of rice bran in the dairy ration is recommended when it can be purchased for less than four-fifths as much per ton as milo chops or corn chops. If the rice bran is to constitute more than a third of the grain ration, the dairyman should watch his cows very closely to find out which ones dislike rice bran, and to feed those cows a ration containing a smaller proportion of rice bran. On account of the readiness with which rice bran becomes rancid the buyer should take care to purchase rice bran as fresh from the mills as possible. On account of the seasonal nature of the rice milling industry, fresh rice bran is easiest to obtain between early September and March or early April.

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# RICE BRAN AS A FEED FOR DAIRY COWS

By

JAY L. LUSH and FRED HALE

## INTRODUCTION

Rice bran is a by-product of the rice-milling industry. The amount which is produced each year naturally varies with the size of the rice crop and also with the methods used in milling. According to United States Department of Agriculture estimates, the annual rice crop of the United States for the last ten years has varied from as low as thirty-three million bushels of rough rice to as high as fifty-two million bushels. A bushel of rough rice weighs 45 pounds. The methods of milling and the quality of the rice cause the yields of rice bran to vary considerably. On the average the yield of rice bran is not very far from 8 per cent of the weight of the rough rice. This results in an annual production of approximately sixty thousand to one hundred thousand tons of rice bran in the United States. Very little of this is exported on account of the risk of its becoming rancid in transit. Therefore, almost the entire amount is available for feeding livestock in the United States. Other by-products of rice milling which are used for feeding livestock are rice polish and brewers' rice, each of which constitutes not far from 3 per cent of the weight of the rough rice. Tailings or rough rice screenings are another by-product of the rice milling industry but are extremely variable in amount produced from a given amount of rough rice, and also vary greatly in feeding value and consist largely of weed seeds, bits of broken rice, balls of mud, and grains of sand. Rough rice screenings are used mostly for chicken feed. Rough rice screenings should not be confused with "rice screenings," which is a trade term for a grade of rice of medium broken size, used mostly for table use.

Nearly half of the rice of the United States is grown in Louisiana. Texas, Arkansas, and California produce nearly all the rest, although a little is produced in the other southern states east of Louisiana. Rice production in Texas is heavily concentrated in two regions, in and near the lower valley of the Colorado river and in the extreme southeastern corner of the state. Figure 1 shows the distribution of rice in Texas in 1924 by acres planted. The chief milling centers are Houston and Beaumont, although there are also mills in Bay City, El Campo, Eagle Lake, Orange and other cities near the producing areas. This limited geographical distribution of the rice industry combined with differences in freight rates naturally results in a similar but less limited region in which the net price of rice by-products to the consumer is low enough that the livestock feeder can well afford to consider using them to replace at least a part of the corn or grain sorghums which ordinarily form most of the grain ration in northern and western Texas. Rice by-products are not ordinarily shipped in very large quantities west of San Antonio or north of Dallas. In the region where most of the rice by-products are fed, most of the regular feeding done is that of dairy cattle, although some feeding of swine is done and, especially in years of low feed prices, considerable numbers of cattle are fattened for market. The experiment stations have already gathered a considerable amount of information on the feeding of rice by-products to swine and to fattening cattle but very little such information has been available on the feeding of rice by-products to dairy cows. The importance of this problem seemed to demand its investigation and accordingly an investigation of the more practical aspects of the question of feeding rice bran to dairy cows was carried out at Substation No. 10, of the Texas Agricultural Experiment Station during 1925 and 1926. Limited funds made it necessary to utilize all the pasture and cheap roughage possible and prevented a complete investigation of this question. Thus, we have been unable to investigate at this time, such aspects of the problem as the true net energy value of rice bran, its effect (if any) upon the quality and palatability of the butter, and any possible physiological effects produced by feeding rice bran to cows for very long periods of time.

### Characteristics of Rice Bran

Bulletin No. 191 of this Experiment Station, "The Composition of Rice and Its By-Products," contains a detailed description of the processes involved in rice milling. It also contains descriptions and analyses of the various by-products. This bulletin is still available for free distribution and the reader is referred to it for detailed information of this kind.. It will be sufficient here to recount only those aspects of the manufacture and composition of rice bran which have an important practical bearing on its use for feeding livestock.

Rice bran consists of particles of the outer coating removed from the rice kernel after the hulls have been taken off. However, in the processes of milling, this material comes out of different machines and is a mixture of the "stone bran," the bran from the "hullers," and the "cone bran." It invariably contains at least a small amount of hulls and, if the miller is careless or deliberately intends to adulterate the bran, the proportion of hulls will sometimes be large enough to lower the feeding value of the bran quite distinctly. The definition of rice bran adopted by the Feed Control Service, which enforces the Texas Feed Law, is as follows: "Rice bran is the pericarp or bran layer of the rice, with only such quantity of hull fragments as is unavoidable in the regular milling of rice. Standard: It must contain not less than 11 per cent of crude protein and 10 per cent of crude fat, and not more than 15 per cent of crude fiber."

The chemical composition of commercial rice bran is more variable than that of most concentrated feeds. Besides the variation already mentioned in the amount of hulls present there is considerable variation in the amount of fat and in the amount of moisture present. Many mills in recent years have installed drying machines, which are used to dry out the bran so that it will not become rancid so readily. This will tend to reduce the variation in the moisture content of commercial rice bran. However, not all mills have these drying machines or "kiln-driers," and some of those mills which do have them only use the driers

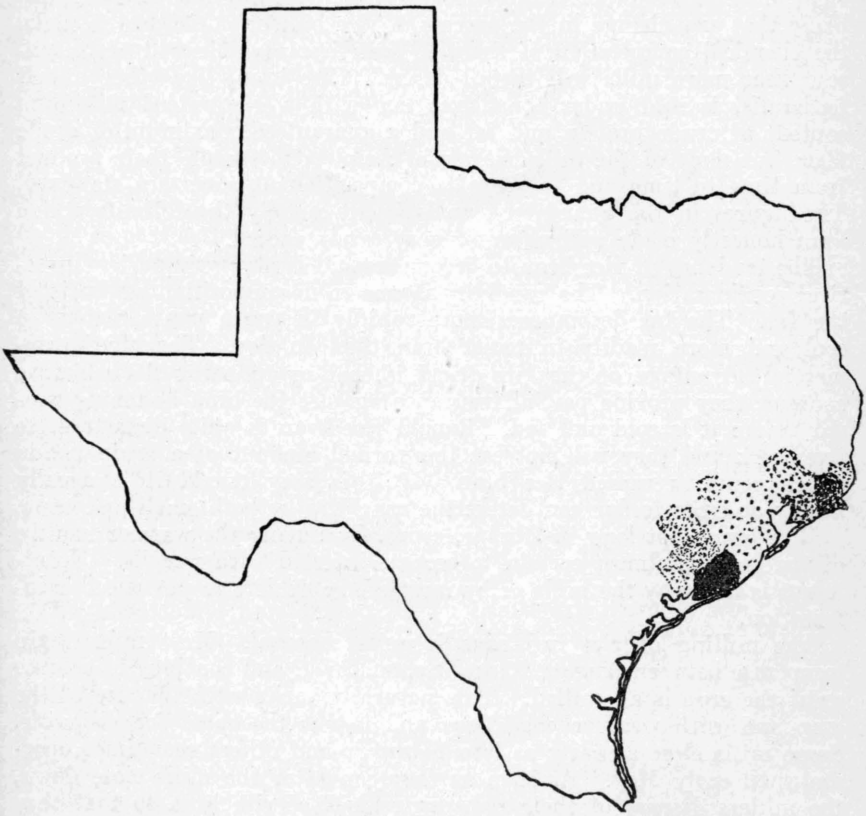

Figure 1. Location and Relative Intensity of Rice Acreage in Texas in 1924.

during wet seasons or in milling lots of rice which are unusually high in moisture content. The feed dealer usually specifies whether or not he is to get kiln-dried bran when he orders from the mill, but there is no distinguishing mark on the sacks and the man who feeds the bran rarely knows whether or not he is buying bran which is kiln-dried. The general opinion among millers is that little is to be gained by kiln-drying bran produced from normally dry lots of rice but that drying helps very much in preventing the development of rancidity in bran made from lots of rice unusually high in moisture content or milled in an unusually damp season. No attempt is made to control the amount of fat in rice bran. From time to time the suggestion is made that bran should have the oil pressed out and should be sold in cake form as cottonseed cake is. In at least one instance a mill was actually built for that purpose but the enterprise did not succeed, whether from lack of a market for the rice oil and bran cake or from insufficient volume of business or for other reasons is uncertain. At any rate it seems unlikely that any change in the process of rice bran manufacture to make the chemical composition of the rice bran less variable will occur, except that more mills will install driers. Rice bran, like other milled feedstuffs, is sold under the Texas law with a guaranteed minimum content of crude protein and fat and a guaranteed maximum of crude fiber, but none of the mills maintain chemists to sample their product from time to time and to keep its composition at a certain standard. The figures in the guaranteed analysis are merely those limits which bran honestly made will never or very rarely exceed.

The tendency of rice bran to become rancid is a very important practical consideration. The rancidity is due to decomposition products of the fat. The fat decomposes more rapidly in warm weather than in cool and more readily in moist bran than in dry. The chief commercial advantage of the kiln-driers is that by reducing the moisture content, they provide partial insurance against the bran becoming rancid before it is sold and fed. Rancid rice bran is quite distasteful to live stock and they will not eat the normal amount of a grain ration which contains rancid rice bran. If it is very rancid it is usually lumpy and the feeder can detect the rancidity by both smell and taste.

Rice bran kept long in storage, especially during the warmer months of the year, is almost certain to become infested with weevils. No attempt is made by the mills or by most of the dealers to prevent this infestation.

The milling of rice in Texas is quite seasonal. Most mills begin to operate between August 20 and September 1, and continue to operate until the crop is all milled. This naturally varies with the size of the crop and with weather conditions and is not the same for all mills. Some mills close as early as late February and others sometimes operate until early May. As soon as they can after the mills close down, the millers dispose of their remaining stock of rice bran so that they will run no risk of having it become rancid or weevilly while still in their possession. Dealers who expect to have customers for rice bran during the summer months lay in a supply of it in the spring to meet that demand. The man who feeds rice bran in the summer months can be reasonably sure that it has been held somewhere in storage for quite a while. The seasonal nature of the rice bran supply is accentuated by its much greater readiness to become rancid and weevilly during the warmer part of the year, the very time when it must be stored to meet possible demand. The practical result of this is a condition aptly expressed by one feeder in the statement: "Rice bran is a fine feed from September to March. The rest of the year I look for something else."

The chemical composition of rice bran leads one to think that its feeding value is more like that of oats than like that of wheat bran. Its content of digestible protein is a little more than that of corn chops, about the same as that of milo chops, only a little less than that of oats, but only about two-thirds as much as that of wheat bran. On the other hand, its net energy content is about a third greater than that of wheat bran, almost equal to that of oats, and about four-fifths that of corn chops or milo chops.

### Previous Feeding Experiments with Rice Bran

The California Experiment Station, Annual Report for 1919, p. 81, reads in part as follows: "Feeding investigations by Lloyd indicate that rice bran which is sweet and free from hulls can be used as a satisfactory substitute for wheat bran in an amount not to exceed 20 per cent of the mash." No other reference to experiments with rice bran as a poultry feed have come to our attention.

Louisiana Experiment Station, Bulletin No. 77, p. 455, reads in part as follows: "Rice bran has been fed with considerable success to horses and mules in Louisiana and elsewhere in the South." Practical feeders have claimed that the amount of hulls in rice bran was sufficient to injure horses in long-continued feeding, but experimental proof or disproof of this statement seems to be lacking. Most such statements can be traced to experiences which were had years ago, before there was any Feed Control Law, when adulteration of rice bran with an excessive quantity of hulls was more common than now.

We have found no reference to published experimental work on the feeding of rice bran to sheep. However, unpublished data (1916-1917 Annual Report of Substation No. 10, Texas Agricultural Experiment Station), collected by J. M. Jones in a fattening experiment with sheep and lambs, show that on account of the unpalatability of the rice bran used the sheep (old ewes) would not eat much more than a third of a pound of rice bran per day and lambs would not eat much more than a quarter of a pound of rice bran per day. The experiment had been planned to test out the comparative value of cottonseed meal and peanut meal as protein supplements and the plan was to feed a grain mixture consisting of four pounds of rice bran to each pound of protein supplement. However, on account of the unpalatability of this ration, it was found necessary to replace a considerable part of the rice bran with milo chops in order to induce the ewes and lambs to eat sufficient concentrates. The average proportions of the concentrate mixture actually fed during the 108-day feeding period were about as follows:

| | Old Ewes | Lambs |
|---|---|---|
| Protein supplement | 26% | 25% |
| Rice bran | 46% | 42% |
| Milo chops | 28% | 33% |

The gains were not very satisfactory, but since the experiment was not planned primarily to test out the feeding value of rice bran, the only positive information which can be drawn from it about rice bran is that this particular lot of rice bran was too unpalatable to be used for as much as half of the concentrated ration for these ewes and lambs.

Rice bran has been fed to swine in a number of experiments (U. S. D. A., Farmers' Bulletin No. 412, Arkansas 128, Texas 224, 286, 305 and 313) with the general conclusions that swine do not like it quite as well as other feeds, and that if fed in very large amounts it will produce soft pork, but that it can be used quite successfully to constitute as much as 45 per cent of the ration.

Rice bran has been used to fatten steers in a number of experiments (U. S. Dept. of Agr., Farmers' Bulletin 412, Texas 76, Texas 182) with the general conclusion that the steers do not like it quite as well as cottonseed meal or ground milo heads, especially if it is a little rancid, but that it produced good gains and is a fairly satisfactory feed. In one experiment (Texas 77) rice bran was worth 60 per cent as much as cottonseed meal when it composed 40 per cent of the grain ration. In another experiment (Texas 182) rice bran produced almost as large gains as milo head chops when added to a ration of cottonseed meal and silage, but was much less palatable.

We have found references to three definite experiments on feeding rice bran or polish to dairy cows. In an Italian experiment (Experiment Station Record, Vol. 38, p. 477) on eight cows it was found that feeding rice polish had no effect upon the quantity or quality of the milk produced and that rice polish compared favorably with wheat bran for maintaining the live weight of the cows. The conclusion was also drawn that the presence of partially ground hulls in ordinary polish may cause coughing. However, another Italian experiment reports favorable results from feeding rice hulls with hay to cattle (Experiment Station Record, Vol. 39, p. 272). In an experiment in India (Experiment Station Record, Vol. 51, p. 676) with two lots of six cows receiving a basal daily ration of 3 pounds cottonseed meal, 3 pounds wheat bran, 2 pounds of gram husk, 16 pounds of brewers' grain (wet), 20 pounds of silage, 10 pounds of green grass, 5 pounds of hay, and 1 ounce of salt, it was found that the addition of 3 pounds of rice bran to the ration increased the milk yield enough to more than pay for the cost of the rice bran. In experiments at the North Carolina Station (North Carolina Bulletin No. 169, in Twenty-second Annual Report), rice bran and wheat bran were compared in various combinations. Only two or three cows were used in most of the experiments and the results were somewhat contradictory. In general, rice bran seemed slightly inferior to wheat bran when fed as the sole concentrate or when constituting most of the concentrate ration, but when rice bran made up only one-third of the concentrate ration it was slightly superior to wheat bran. It is noted that in trials with the entire college dairy heard, rice bran proved distasteful to some of the cows but not to others, whereas wheat bran was liked by all of them.

## MATERIAL AND METHODS USED IN THIS EXPERIMENT

The cows used in this experiment were Jerseys, and included all cows in the Feeding and Breeding Station herd which were in suitable stages of lactation, and otherwise comparable. There were two groups of cows with the same number of cows in each group. The cows were paired so as to have each pair as nearly as possible alike relative to period of lactation, length of time since they had been bred, and milk production. One cow from each pair constituted Group A and the cows paired with those in Group A constituted .Group B. Cows which became sick or otherwise failed to go through their lactation period in a normal way were removed from the experiment. Eight cows constituted Group B of the first experiment. There were nine cows in Group A in the first experiment and in each group in both the later experiments. These numbers do not include cows which were started on experiment but were later removed on account of abnormal behavior.

Three experiments were conducted, each experiment covering a 90-day period. The first experiment started November 25, 1925, and closed February 22, 1926. The second experiment was from February 26, 1926, to May 26, 1926. The third experiment was from June 8, 1926, to September 5, 1926.

All of the cows were turned out to pasture or in milo stalk fields whenever the weather was favorable. Oat pasture furnished some grazing in the winter and early spring. The best pasture was available in April. The summer months were dry and little green stuff was available except in June and early July. Water and salt were available to the cows at all times.

The "double reversal" method of feeding was used in these experiments. In this method, one group of cows is fed one of the rations to be tested and the other group of cows is fed the other ration for a given period of time. Then there follows a similar period in which the rations are reversed for the two groups, and then a third period in which the original ration is fed to each group. Each period for these experiments consisted of thirty days, the first ten days of each constituted a preliminary period during which the animals might become accustomed to the change in the ration, and the last twenty days of the period was regarded as furnishing the most reliable data.

The cows were fed their concentrate ration and were milked in the Feeding and Breeding Station dairy barn twice daily. Cottonseed hulls were fed in racks in the open ad libitum. During the first experiment prairie hay was fed to four cows of each group ad libitum. Sorghum silage was fed to both groups during the first 42 days of the first 90-day experiment and during the last 12 days of the third 90-day experiment.

The grain mixture for one group consisted of:

| | |
|---|---|
| Ground milo | 300 pounds |
| Prime cottonseed meal | 100 pounds |
| Wheat bran | 100 pounds |
| Bone meal | 10 pounds |
| Salt | 5 pounds |

The other group received a grain mixture composed of the following:

| | |
|---|---|
| Ground milo | 150 pounds |
| Rice bran | 200 pounds |
| Wheat bran | 100 pounds |
| Prime cottonseed meal | 100 pounds |
| Bone meal | 11 pounds |
| Salt | 5.5 pounds |

The grain ration for each cow was regulated according to the amount of milk produced. A five-day moving average of the milk production was used as a basis for calculating the amount of grain to be fed to each cow. All feeds were weighed to the animals, and $1\frac{1}{3}$ pounds of cottonseed meal were added to each cow's daily grain ration in order to fulfill maintenance requirements. After January 13, when the silage supply was exhausted, 3 pounds of a mixture of equal parts of cottonseed meal and ground milo were fed to each cow for maintenance requirements.

From what was known of the chemical composition and digestibility of rice bran, we expected it to have a net energy value a little more than three-fourths as great as that of ground milo. The rations were planned to test this out. Cows receiving the rice bran mixture were allowed 10 per cent more grain per pound of milk produced than cows receiving the milo mixture were allowed. This was done because the theoretical net energy value of the milo mixture was about 10 per cent greater than that of an equal weight of the rice bran mixture and we desired to give all cows the same amount of net energy per pound of milk produced. Expressed in practical terms, we desired to find out whether 200 pounds of rice bran actually would replace 150 pounds of milo chops for milk production, as theory led us to expect it would.

The individual live weights of these cows were taken at the beginning and end of each 30-day period. Records were obtained for each cow on the amount of grain and of silage consumed, milk and butterfat produced, and changes in live weight. Data on differences in the flavor of the milk produced were also obtained and notes were made of the palatability of the rations.

The average chemical composition of the feeds actually fed as determined by analyses of samples at regular intervals is shown in Table I.

Table 1.—Analyses* of feeds used in Project No. 208, feeding rice bran to dairy cows.

| | No. of Analyses | Crude Protein | Fat | C. F. | N. F. E. | $H_2O$. | Ash |
|---|---|---|---|---|---|---|---|
| Cottonseed meal....... | 5 | 42.21 | 6.16 | 11.59 | 26.50 | 8.40 | 5.14 |
| Rice bran............ | 4 | 12.59 | 10.75 | 11.86 | 47.03 | 8.15 | 9.62 |
| Milo chops........... | 4 | 10.75 | 2.52 | 2.63 | 71.03 | 11.10 | 1.97 |
| Cottonseed hulls....... | 3 | 6.13 | 2.69 | 40.94 | 39.42 | 7.98 | 2.84 |
| Wheat bran........... | 2 | 16.76 | 3.87 | 10.46 | 52.42 | 9.60 | 6.88 |
| Prairie hay........... | 1 | 4.70 | 2.26 | 29.77 | 48.41 | 7.20 | 7.66 |

*Analyses made by Division of Chemistry, Texas Agricultural Experiment Station.

## RESULTS OF THESE EXPERIMENTS

### Yield of Milk

The effect, if any, of the rice bran upon the amount of milk produced should be shown by the difference between the average production of the cows for the first and third thirty days of each experiment and their production for the second thirty days. However, both groups of cows must be considered in this comparison as otherwise unusually favorable weather or pasture conditions during one of the thirty-day periods might have an influence on the milk yield which could not be distinguished from an effect of the ration. In this experiment the milk and feed records were analyzed separately for the first ten days and the last twenty days of each thirty-day period as it was thought possible that some time might be required for the cows to become accustomed to the changes in the rations and the first ten days' records might show the effects of the cow's slowness in adapting herself to the new ration.

In the first test, which was carried on during the winter season from late November to late February, silage was available to the cows in boths lots during the first half of the test. After the supply of silage was exhausted the cows, whenever the fields were not too muddy, had access to oat pasture. However, this was not very often and the only other feed provided, besides the grain ration, was prairie hay for four cows from each lot, and cottonseed hulls for the other cows in each lot. In the comparison between the first ten days of each period, Group A produced 3.86 pounds more of milk per cow while on the rice bran ration and Group B produced 2.82 pounds more of milk per cow while on the milo ration, which makes a net difference, presumably due to the ration, of 1.04 pounds of milk per cow in ten days in favor of the rice bran ration. This small difference of one-tenth of a pound of milk per cow per day is well within the limits of experimental error.*

*By experimental error is meant the small amount of variation in the results of an experiment caused by uncontrolled conditions of the test. If all condi-

The results from the comparison of the twenty-day periods show that Group A averaged 49.39 pounds more of milk per cow while on the rice bran ration, but that Group B averaged 34.60 pounds more of milk per cow while on the milo ration, leaving a net difference, presumably, due to the ration, of 14.79 pounds of milk per cow for twenty days, or practically three-fourths of a pound of milk per cow per day in favor of the rice bran ration.

In the second test the results of the ten-day comparisons show that Group A produced 4.66 pounds more of milk per cow while on the rice bran dation, but that Group B produced 13.16 pounds more of milk per cow while on the milo ration, making a net difference of 8.5 pounds more milk per cow, presumably due to the ration, in favor of the milo ration. This is a little less than a pound per cow per day. In the twenty-day comparison, Group A produced 5.41 pounds more of milk per cow on the milo ration, but the cows of Group B produced 6.31 pounds more of milk per cow while on the rice bran ration, a net difference of .90 pound per cow or less than one-twentieth of a pound more milk per cow per day, presumably due to the ration, in favor of the rice bran ration.

During the third test, which was carried on during the summer months, the ten-day comparison shows that Group A produced 13.97 pounds more milk per cow on the rice bran ration, but that Group B produced 8.48 pounds more milk per cow on the milo ration, leaving a net difference of 5.49 pounds more milk per cow or practically a half pound per cow per day, presumably due to the ration, in favor of the rice bran ration. The twenty-day comparison shows that Group A produced 9.73 pounds more milk per cow on the milo ration, but that Group B produced 15.17 pounds more milk per cow on the rice bran ration, a net difference of 5.44 pounds more milk per cow or practically one-quarter of a pound of milk per cow per day, presumably due to the ration, in favor of the rice bran ration.

Thus we see that in five of the six possible comparisons the rice bran ration seemed to have caused a higher milk yield, but all those differences were fairly small. We can only answer in an empirical way the

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tions in an experiment could be perfectly controlled, duplicate experiments would always give identical results. and it would only be necessary to conduct one experiment to find the exact answer to any one specific question; that is, there would be no experimental error. However, such perfectly controlled conditions are not possible in experiments with living animals, and it is necessary to repeat experiments several times and to study the variations in their results, using the intricate mathematics of probability, to determine how much of the difference between the results from two lots is probably due to these uncontrolled variations and how much of it is really due to the difference in the ration which the experiment was planned to test. Thus in the comparison just given, experimental error could very easily account for a difference of one-fifth of a pound of milk per cow per day, and we would not be at all sure that anything except experimental error was involved unless the difference was at least as great as two-thirds of a pound per cow per day instead of the difference of one-tenth of a pound actually observed per cow per day.

question of whether the differences in milk yield, presumably due to the ration, were really due to the ration or to some other chance combination of circumstances. By statistical methods we find that in four of the five comparisons favorable to the rice bran ration, the difference between the two lots was well within the limits of experimental error. In the fifth comparison, which resulted favorably to the rice bran ration, the odds are about five against two that the difference between the two lots was not accidental. However, in the only one of the six comparisons which resulted favorably to the milo ration, the odds are about forty-five against one that the difference between the two lots was not accidental. However, during the time covered by this comparison, the cows on the rice bran ration were particularly bad about refusing to eat all the grain offered them. The apparent superiority of the milo ration was probably caused by the failure of the cows to eat the planned *amount* of the rice bran ration rather than by any superior quality of the milo ration over the rice bran ration as planned. Our interpretation of these conflicting results is that the difference in the composition of the grain rations fed to the cows was not the cause of the small differences in milk production actually observed.

### Consumption of Feed

As already stated, we had planned to feed 10 per cent more of the rice bran ration than of the milo ration, both rations being fed in proportion to milk production. However, when a cow persistently refused to eat as much grain as was offered her on this basis, it was, of course, necessary to reduce her grain ration. From the very beginning it was evident that as a rule the cows did not relish the rice bran ration as well as they did the milo ration. Not all the cows were alike in this. Some cows would make no noticeable objection to the rice bran ration, but there were always a few, usually two or three out of each group of nine, which would eat their full allowance when on the milo ration but would consistently refuse to eat their full allowance when on the rice bran ration. When the pastures were bare or unavailable this distaste for rice bran was not very noticeable, but it reached its climax during late March and April when the pastures were at their best and nearly every cow showed unwillingness to consume her full allowance of the rice bran ration. Several also failed to consume quite their full allowance of the milo ration during April, but this tendency was by no means as pronounced as among the cows on the rice bran ration at the same time. During the cold winter months when little pasture was available, Group A ate 4.4 per cent more and Group B ate 6.1 per cent more of the rice bran ration instead of the 10 per cent more which it was planned they should eat.

During the second test Group A ate an average rice bran ration [illegible].2 per cent larger than their average milo ration. However, the cows of Group B ate an average rice bran ration 18.4 per cent *less* than their average milo ration. In both cases it had been planned to give the cows the opportunity to eat about 10 per cent more of the rice bran ration than of the milo ration, the figures being slightly adjusted, of course, to allow for unexpectedly large or small decreases in milk yield as the lactation period advanced. The difference in feed consumption between the two lots is due to the fact that the good pastures became available just as Group B was being changed to the rice bran ration and Group A was being changed to the milo ration. Group B refused a large portion of their grain ration and Group A refused only a little of theirs.

During the third experiment the cows of Group A ate 3.0 per cent less of the rice bran ration than of the milo ration, while the cows of Group B ate 4.6 per cent more of the rice bran ration. The difference in the behavior of the two lots in this case was due to a fair supply of pasture during June, when the cows of Group A were refusing to eat all of their rice bran ration. By July, when the cows of Group B were changed to the rice bran ration, the pastures had dried up so much that the cows of both groups consumed nearly all of the grain ration offered to them. For the entire experiment the cows consumed an average rice bran ration which was 0.4 per cent smaller than the milo ration instead of 10 per cent larger than the milo ration as we had planned. Throughout the experiment this preference of the cows for the milo ration existed, but it became especially noticeable only at such times as there was plenty of good pasture available. The result was that the cows ate all or nearly all of the rice bran ration they needed when weather conditions and the outside feed supply were poor, but only ate sparingly of the rice bran ration when plenty of outside feed could be had. This gave rise to the totally unexpected result that because the rice bran ration was less palatable the feed cost (expressed in terms of net energy) of the milk produced on it was lower than that of the milk produced on the more palatable ration. Since we have no record of the amount of feed secured by each group of cows from pasture and from roughage other than silage, we have no means of knowing whether the cows on the rice bran ration ate enough more pasture and roughage to make up for the grain they refused. Presumably they did do this, at least to a considerable extent. The fact that the cows discriminated most against the rice bran when the pastures were best gives some support to this idea. However, we cannot deny the possibility that our preliminary estimates of the relative value of rice bran and milo for milk production may have been somewhat at fault when we planned the rations.

It is necessary to note here that the very best pasture was available during the period when the milk yields were being made which resulted in the only comparison favorable to milo. The markedly lowered consumption of rice bran during this period makes one almost certain that the increased production on the milo ration was a result of increased feed consumption, not of a better quality of ration, and confirms our previous conclusion that the difference in the kind of rations fed during this experiment had no effect upon the amount of milk produced.

**Flavor of Milk**

Some of the textbooks on feeding contain the statement that rice bran even when not rancid will injure the quality of the milk if fed to dairy cows in large amounts. As a part of our experiments we tested out that statement and did not find evidence to support it.

Our test ration contained only 36 per cent of rice bran, and when we could get no consistent answer by questioning our regular retail customers as to which of the two kinds of milk had the more desirable flavor, we decided to feed a few cows enough rice bran to produce a decided flavor if that were possible. Accordingly, four of the heaviest producing cows in the herd but not included in either Group A or Group B were fed a ration consisting of 90 per cent rice bran and 10 per cent cottonseed meal for more than a week. All four cows showed unmistakably that the ration was unpalatable to them. One of them refused to eat enough of it for us to consider her milk as having had a chance to be fully affected, and she had to be removed from this test. The other three ate fairly large quantities of the ration, but not as much as their milk production justified, and all three declined in milk production.

Because flavor is so largely a matter of personal opinion and no objective means for judging it were available, we carried the milk to three classes of senior and junior students majoring in dairy husbandry and asked them to rank the samples in the order of their flavor. Each student was given two duplicate samples of milk from cows getting a heavy rice bran ration and two duplicate samples of milk from cows which were receiving no rice bran whatever. However, the students supposed they were tasting four different kinds of milk.

Twenty-six students tasted the milk. Four rated the two rice bran samples first and second, three rated them first and third, four rated them first and fourth, five rated them second and third, three rated them second and fourth, one rated them third and fourth, one said all samples tasted equally good, one said that one of the rice bran samples was best but the other three were all alike, one said a rice bran sample was best and the other rice bran sample and one of the other samples were intermediate, while the fourth sample was poorest, one said that one of the milo samples was best, the other three being equally good, one rated the rice bran samples as first and fourth, with the two milo samples being equally good for second and third place. Finally, one student rated the two rice bran samples and one milo sample as equally good but declared the other milo sample was poorest.

From this mass of conflicting testimony we can draw the sure conclusion that there was no real difference in the flavor of the two lots of milk, and that rice bran which is not rancid does not injure the flavor of whole milk. We made no investigation of the quality of butter which could be made from cream produced on the two rations. Some early German investigators* have reported that feeding large amounts of rice bran causes the butter to be softer and more smeary and to have a less desirable taste. In general, they report that the flavor and quality of the milk were not affected. Aside from the question of whether these investigators used methods adequate to substantiate their conclusions completely, there remains the possibility that the rice bran with which they were working was at least slightly rancid. Germany is a considerable distance from most rice-producing regions and therefore it is quite unlikely that the rice bran used by these investigators was strictly fresh, even though it may not have been very noticeably rancid. Our judgment is that the supposedly harmful effect of fresh rice bran on the quality and flavor of butter has not been proved conclusively, although such an effect is theoretically possible. The fact that a heavy rice bran ration fed to hogs is known to produce soft pork might lead one to expect such an effect also on butter. Further evidence on this point is needed.

### Net Energy Value of Rice Bran as Compared with Milo Chops

In planning this experiment it was assumed, on the basis of the information then available, that the net energy value of rice bran was about 75 per cent as great as that of milo chops. The most recent average figure available† on that point is 79.6 per cent, but due to variations in composition and in digestibility of the two feeds, this figure may be somewhat different for any particular lots of feed. Using the actual chemical composition of the feeds fed and assuming average digestibility and average availability for productive purposes of the feed digested, the net energy content of the rice bran used was 69.2 therms, and that of the milo chops was 86.0 therms per hundred pounds of feed.

The actual results of this experiment can be used for calculating the net energy value of rice bran only when the assumption is made that the cows on the rice bran ration ate just the same amount of roughage and of pasture as the cows on the milo ration. Such an assumption is probably not justified, especially in view of the fact that the cows on the rice bran ration showed the most distaste for it when the pastures were best. It seems certain that the cows on the rice bran ration made more use of the available pasture and probably also more use of the roughage than did the cows on the milo ration. This is an economic advantage in favor of the rice bran in a region such as this where abundant pasture is available for only very limited seasons and

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*Pott, "Handbuch der Tierischen Ernährung und der Landwirtschaftlichen Futtermittel," Volume III, pp. 191-193.

†Texas Agricultural Experiment Station Bulletin No. 341, "Cottonseed Products as Feed, Fertilizer and Human Food." (See especially page 7.)

it is desired to make the fullest possible use of pastures and of roughage in order to cheapen the cost of production. Nevertheless, this circumstance under the conditions of these experiments makes it impossible to place much confidence in the figures derived from these experiments with respect to the *net energy value* of rice bran. However, those figures and the calculations upon which they are based are given in Tables 2 and 3 so that those interested may see the method of calculation. The cows were weighed on only one day at the beginning or end of each thirty-day period and on account of the relative unreliability of a single-day weight more confidence can probably be placed in the net energy figures obtained when weight changes were neglected. However, the figures thus obtained for the energy value of rice bran are about 20 per cent higher than the figures calculated from the chemical composition of rice bran. In view of the uncertainty about the amount of pasture and roughage utilized, the most positive conclusion justified is that these figures suggest that the true net energy value of rice bran is somewhat higher than its chemical composition indicates. Further experiments with more frequent weighings and with cows kept from pasture throughout the test and with all the roughage carefully weighed would be required to determine definitely the net energy value of rice bran as compared to milo chops.

Table 2.—Differences per cow in feed consumption, milk production and body weight change.

Consumption during second 30 days minus average consumption during first 30 days and third 30 days.

| | Milo Chops | Cotton seed Meal | Wheat Bran | Rice Bran | Silage | Milk Production | Body Weight |
|---|---|---|---|---|---|---|---|
| Experiment I. | | | | | | | |
| Group A (started on rice bran) | + 62.85 | +2.17 | +2.17 | — 81.13 | —30 | —53.26 | —15.11 (loss on milo) |
| Group B (started on milo) | — 93.08 | —1.505 | —1.505 | + 82.09 | —30 | —37.42 | +13.44 (gain on rice bran) |
| Difference A—B | +155.93 | +3.675 | +3.675 | —163.22 | 0 | —15.84 | —28.55 |
| Experiment II. | | | | | | | |
| Group A (started on rice bran) | + 62.21 | + 1.48 | + 1.39 | — 77.26 | ......... | + .76 | +54.85 (gain on milo) |
| Group B (started on milo) | — 88.47 | —12.11 | —12.11 | + 69.53 | ......... | — 6.85 | +54.45 (gain on rice bran) |
| Difference A—B | +150.68 | +13.59 | +13.59 | —146.79 | ......... | + 7.61 | + 0.40 |
| Experiment III. | | | | | | | |
| Group A (started on rice bran) | +63.95 | + 5.04 | + 4.46 | —66.66 | —107.5 | — 4.23 | +70.75 (gain on milo) |
| Group B (started on milo) | — 72.56 | — 2.28 | — 2.28 | + 87.64 | —107.5 | + 6.68 | + 4.78 (gain on rice bran) |
| Difference A—B | +136.51 | + 7.32 | + 6.74 | —154.30 | 0 | —10.91 | +65.97 |

| | Rice Bran | | Milo Chops | | Cotton-seed Meal | | Wheat Bran | | Pounds Milk | | Pounds Live Wt. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| From Experiment I | 163.22 lbs. | = | 155.93 | + | 3.675 | + | 3.675 | + | 15.84 | + | 28.55 |
| From Experiment II | 146.79 lbs. | = | 150.68 | + | 13.59 | + | 13.59 | — | 7.61 | — | .40 |
| From Experiment III | 154.30 lbs. | = | 136.51 | + | 7.32 | + | 6.74 | + | 10.91 | — | 65.97 |

Hulls and pasture (when available) given to both groups of cows ad libitum. All figures in pounds and on a per cow for one month basis.

Table 3.—Calculation of productive value of rice bran in therms.*

| | Pounds | Productive Value | Pounds | Productive Value | Pounds | Productive Value |
|---|---|---|---|---|---|---|
| Rice bran x .692..... | 163.2 | 112.9 | 146.8 | 101.6 | 154.3 | 106.8 |
| Milo x .86........... | 155.9 | 134.1 | 150.7 | 129.6 | 136.5 | 117.4 |
| Cottonseed meal x .70 | 3.7 | 2.6 | 13.6 | 9.5 | 7.3 | 5.1 |
| Wheat bran x .436... | 3.7 | 1.6 | 13.6 | 5.9 | 6.7 | 2.9 |
| Milk x .30 .......... | +15.8 | +4.7 | —7.6 | —2.3 | +10.9 | +3.3 |
| Weight x 1.1 ........ | +28.6 | +31.5 | 0 | .......... | —66.0 | —72.6 |
| Total +...... | +207.7 | +174.5 | +177.9 | +145.1 | +161.4 | +128.7 |
| Total —...... | .......... | .......... | — 7.6 | — 2.3 | — 66.0 | — 72.6 |
| | 207.7 | 174.5 | 170.3 | 142.8 | 95.4 | 56.1 |
| | | 31.5 | | | | |
| | | 143.0 | | | | |

| | Pounds of Rice Bran | Therms per 100 lbs. of Rice Bran |
|---|---|---|
| Changes in weight included....... | 174.5 ÷ 163 =................. | 107.1 |
| | 142.8 ÷ 147 =................. | 97.1 |
| | 56.1 ÷ 154 =................. | 34.6 |
| Disregarding changes in weight.... | 143.0 ÷ 163 =................. | 87.7 |
| | 142.8 ÷ 147 =................. | 97.1 |
| | 128.7 ÷ 154 =................. | 83.6 |

*By Dr. G. S. Fraps, Chief Division of Chemistry.

## Discussion

In many or all of the experiments quoted in this Bulletin, and in our own experiments, the rice bran used was purchased through a dealer and had been shipped some distance from the mill. Therefore, it was not in the freshest possible condition. In most of the experiments quoted and in our own experiments care was taken that the rice bran did not smell or taste rancid and had not caked. However, it is possible that bran freshly milled might be somewhat more appetizing to animals than bran which had been in storage some time but still was not rancid in odor or taste as far as human senses could tell. If this is the case, then feeders living within hauling distance of the mills, or buying through a dealer who is careful to buy and sell only real fresh rice bran, might not encounter as much distaste for a heavy ration of rice bran as was found in these experiments. Any feeder can determine readily whether his cows like their rice bran ration by substituting another ration for a day or two and then observing whether his cows will readily eat as much of the rice bran ration as of the other.

The dairyman who is feeding for maximum production with little or no regard for expense will probably not want to consider the use of very much rice bran in his rations because any unpalatability of the ration would probably reduce at least slightly the feed consumption and milk production of his cows. Practically the only cows thus fed for maximum production with little regard to cost are cows on Register of Merit tests.

## CONCLUSIONS

Rice bran can replace milo chops in the dairy ration at the rate of four pounds of rice bran in place of three pounds of milo chops and can make up as much as 36 per cent of the ration without causing any decrease in milk yield.

When it makes up this much of the ration, some of the cows will find the ration rather unpalatable but this will be very noticeable only when there is an abundance of pasture or other feed besides the grain ration.

Rice bran which was not rancid had no effect upon the flavor of milk produced by cows which ate a grain mixture consisting of 90 per cent rice bran and 10 per cent cottonseed meal.

The net energy content of rice bran is estimated to be between 75 per cent and 80 per cent as large as that of milo chops and the digestible protein content is about the same. However, the composition of rice bran varies considerably. Except for its unpalatability, rice bran could be substituted in any dairy ration on that basis. On account of its unpalatability rice bran should not ordinarily make up more than a third of the grain ration for cows which have not been accustomed to it.

Cows differ in the amount of distaste they show for rice bran. It is possible that those cows accustomed to it for long periods of time might not show so much distaste. That point was not investigated.

Fresh non-rancid rice bran is a desirable and economical dairy feed when it can be purchased at a price corresponding to its net energy value or lower. Its lowest prices usually prevail during the fall and winter months when there is also the least chance of its being rancid or weevilly and when the scarcity of green pasture makes the cows eat it most readily. This peculiar combination of circumstances makes rice bran, more than almost any other common concentrated feed, a highly seasonal feed. Fortunately, the seasons when it is best are the seasons in which most concentrated feed is usually needed by dairy cows in Central and Southeast Texas.

Our data indicate that the theoretical net energy value of 68 therms for rice bran is too low, but the data do not prove it since it is possible that the cows under the conditions of our experiments ate enough more pasture and hulls to make up for the deficiency of their ration in net energy.