HOW CHANGES IN FEED AFFECT THE YIELD OF MILK.

F. H. HALL AND W. P. WHEELER.

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HOW CHANGES IN FEED AFFECT THE YIELD OF MILK.

F. H. HALL.

Several years ago this Station made and reported an extensive breed test with dairy cows. This work included many animals and was continued for a long time, so that a great mass of data was collected. Accurate records were kept of the kind, composition and amounts of feed eaten, of the quantity and quality of the milk produced, and of the gain or loss in weight, by the individual cows; but only so much of these records was published as was necessary to show the merits of the different breeds as milk producers. Data from later feeding of the same herd were also kept, but have not hitherto been printed in any form.

No attempt was made, in the breed-test bulletins, to discuss the data from the standpoint of the feeder. Yet in the tests, without planning such a result, the factors in the feeding varied much as they might do in a carefully devised feeding experiment. The feeds were changed many times, nearly all of the common grains and coarse fodders being fed and some that were not in general use. Consequent upon these feed-changes there were variations in the total amounts, and in the relative proportions of protein, carbohydrates and fat fed at different times. These changes were not great enough, however, to prevent a healthy, normal flow of milk. The

*This is a brief review of Bulletin No. 210 of this Station on The Immediate Effect on Milk Production of Changes in the Ration, by W. P. Wheeler. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed upon the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.
rations were from good, palatable materials and were made to supply what was considered a sufficient amount of food for the animals receiving them; but some were much wider or narrower in nutritive ratio than others; some gave a large amount of energy, others a moderate supply. Hence, though the changes were not made as systematically as they would be in scientific solving of feeding problems nor comparisons made with check animals, yet the data taken were so complete that it is possible to study the results from the feeding side. The records include so many animals and extend over so long a time of careful feeding that it seemed desirable to ascertain what light they shed upon feeding problems. The number and completeness of the data give weight to any conclusions which can properly be based upon them.

The feeding periods under unchanged rations

**Treatment** were too short, in many instances, to show the effect of the feeds in sustaining milk production; so only the immediate effect of changing the rations is considered. "Do certain changes in the ration stimulate or depress the milk flow?" is the question asked.

In computation, the records were worked out for from two to three weeks before a change in the feeding, and for a similar period after, each cow being considered by herself. The records selected were taken when only very moderate changes in the milk flow might be expected; but normal rates of decrease for various portions of the lactation period were carefully estimated, and were considered in studying the effect of the changes in the ration.

Of the short-period, individual records, nearly a thousand were used, these falling into 111 groups by rations, averaging nine cows each, when arranged according to the same foods. The records were again classified according to the direction and amount of change when a new ration was substituted for the one in use; and the figures for the individual cows were averaged to show the effect of the change. It is these averages which are here discussed.

In grouping the rations, four factors were considered: (1) The total digestible organic nutrients, or, in other words, the entire
weight of food, aside from the mineral elements, which is available for use in making milk, in building up tissue or in supplying energy; (2) the fuel value, which is the measure of the energy set free by burning the digestible portion of the ration; (3) the protein, the nitrogen-containing portion of the food, and (4) the nutritive ratio, or relation existing between the protein and the carbohydrates and fat in the food. For practical purposes, however, the fuel value is so closely connected with the total amount of food that we need not discuss them separately; and, in the same way, changes in nutritive ratio follow changes in the amount of protein with only slight variations.

As central points, the food requirements of milch cows, as fixed by the commonly used standards, are taken—15.5 lbs. of total digestible organic matter, and 2.5 lbs of protein for each 1,000 lbs. live weight.

An idea of the prevailing composition of the rations and of their efficiency is given by the following data: Under 1 is the average from 90 individual records for one month with rations having a fuel value of considerably less than 30,000 heat units and supplying less than 15.5 lbs. of total digestible organic matter. Under 2 is the average from 80 individual records for one month with rations having a fuel value considerably higher than 30,000 heat units and supplying considerably more than 15.5 lbs. of total digestible organic matter.

**Averages from Records for One Month.**

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
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<tbody>
<tr>
<td>Average age of cows, years</td>
<td>4</td>
<td>5.6</td>
</tr>
<tr>
<td>Average live weight per cow, lbs.</td>
<td>894</td>
<td>967</td>
</tr>
<tr>
<td>Average month of lactation</td>
<td>6.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Average gain in live weight for month, lbs.</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Fuel value of ration per 1000 lbs. live weight, Calories</td>
<td>28,855</td>
<td>33,937</td>
</tr>
<tr>
<td>Total digestible organic nutrients per 1000 lbs. live wt., lbs</td>
<td>14.6</td>
<td>17.0</td>
</tr>
<tr>
<td>Digestible protein per 1000 lbs. live weight, lbs</td>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td>Nutritive ratio</td>
<td>1.66</td>
<td>1.72</td>
</tr>
<tr>
<td>Milk yield, average per day per cow, lbs</td>
<td>20.2</td>
<td>25.9</td>
</tr>
<tr>
<td>Total solids in milk, average per day per cow, lbs</td>
<td>2.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Percentage of fat in milk</td>
<td>4.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Digestible dry matter in food for one pound of milk solids produced, lbs</td>
<td>4.6</td>
<td>4.8</td>
</tr>
</tbody>
</table>
After the computations were made it appeared that 126 individual records showed changes in the feeds composing the rations without any substantial change in the nutritive elements contained. The milk yield showed no effect, on the average, from such changes; but diminished at the same rate before and after the feeds were changed—at the rate of decrease normal to the time in milk. The foods did, on the whole, have a little greater fuel value—fattening material, evidently, for the cows gained weight slightly faster after the change than before it. It is evident that, so far as these cows were concerned, the food constituents from one source were as effective as those from other sources. It was the amount of protein, carbohydrates and fat, not the source from which these came, which governed the yield.

The total amount of food was increased in 268 cases of ration-change, and decreased in 263 cases, the gain or loss of digestible nutrients averaging about 1 1/2 lbs. in each case.

This amount added to the ration sustained the milk flow without loss, overcoming the natural tendency to shrinkage; and increased the weight of the cows quite rapidly. This favorable influence of added nutrients was shown whether the addition was to a small ration, to a good ration, or to a large ration, though the gain in the last instance was less pronounced than in the first two. Of course cows giving larger yields of milk were included in the records where heavy rations were fed, the average yields for the three classes of rations just noted being 20 lbs., 23 lbs. and 24 lbs., respectively.

A corresponding loss of nutrients when the rations were changed doubled the normal decrease in milk flow and diminished the gain in flesh. When the nutrients in the feed averaged about 18.4 lbs., changes reducing the amount two pounds lowered the milk yield from 23.7 to 22.6 lbs.; when a change of about one pound in the nutrients reduced them from above 15.5 lbs. to below that figure, the milk yield shrank from 24.4 lbs. to 22.6 lbs.; when the ration was small, diminishing the nutrients about a pound and thus bringing them to an average of 13.9 lbs. reduced the milk flow from 19.7 lbs. to 19 lbs. In general, the milk flow
increased most or diminished least when the greatest increase was made in the total amount of digestible food supplied, without regard to moderate changes in protein content; and the most rapid shrinkage in milk yield accompanied the greatest reduction in nutrients. This reduction, however, was usually associated with a reduction of protein.

Regarding the tests as a whole, changes in the amount of protein, within ordinary limits, produced less effect than changes in the total nutrients. As shown by 273 records an increase of about .4 lb. of protein, with cows averaging 22½ lbs. of milk, reduced the normal rate of shrinkage about one-half; a similar decrease in the protein in 297 records of cows averaging 21½ lbs. of milk was followed by a more than normal decrease in the rate of flow.

When the protein was unchanged but the nutrients increased, the milk flow showed a slight average increase; but additional protein with the total amount of nutrients unchanged, did not appear to check the natural diminution in yield. This same greater effect of nutrient-changes than of protein-changes is noted, also, when the records showing increase of protein are considered. Those records, 131 in number, where the protein increase was accompanied by an increase in the total digestible food, show no shrinkage in milk yield, overcoming the natural decrease; the 74 records showing protein-increase with a decrease in actual food supplied show a milk flow decreasing more rapidly than normal.

These figures, subject as they are to the influence of imperfectly controlled conditions, still "mean much more in a practical way than some offered to the public which involve the use of very few animals during only two or three feeding periods." They support much of the observation and experiment of late years in one important point, viz.: "that changes in the quantity of nutrients has greatly more influence on the milk yield than proportionally large changes in the amount of protein. If the available energy of the ration is sufficient, and is kept at a uniform point, there may be quite a wide range in the nutritive ratio without materi-
ally affecting the milk flow.” In other words the evidence tends to show that the feeder of milch cows may, to a greater extent than was believed possible a few years ago, make up a productive ration from a selected list of crops grown on the farm.