Least-Cost Rations and Feed Analysis

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Introduction

Approximately 550,000 cattle are fed to slaughter annually in South Dakota. Regardless of whether feed is raised or purchased, it comprises the biggest single cost to the cattle feeder. Properly formulated diets, using the most economical feedstuffs will significantly decrease the average feed cost and may improve the profitability of cattle feeding.

The advent of micro-computer technology has stirred tremendous interest in least-cost ration formulation. The terms "least-cost rations" and "computer rations" are often used synonymously. A computer is not required to formulate least-cost rations. However, the computer greatly speeds the calculations and serves as a store house for information.

Extension agents, state specialists and other nutrition consultants often receive the request to provide "least-cost rations". Little or no additional information is generally provided. In order to formulate least-cost rations, specific information concerning potential feed ingredients and the cattle to be fed is required.

The objectives of this paper are to: 1) outline the information necessary to formulate least-cost rations and 2) demonstrate the value of feed analysis and proper ration formulation.

Feed Ingredient Information

Farming operations, storage facilities and the availability of purchased feedstuffs vary tremendously. Consequently, not all cattle feeders have access to the same feeds at the same prices. The feed ingredients available, either raised or purchased, and the purchase price or market value of each are absolute necessities when formulating least-cost rations.

The most economical feed ingredients are not those with simply the lowest price per bushel or per unit weight. Moisture and nutrient content, energy density, bushel weight and price must all be considered. In addition, storage, processing and other costs associated with feeding each feed ingredient must be considered.
Table 1. shows the composition of feed grains typically available to South Dakota cattle feeders. Corn and wheat contain more energy than the other grains and usually command a higher price per bushel. Barley, millet, rye and wheat are higher in protein than corn and may be more valuable when the price of protein supplement is high. All feed grains are relatively low in calcium.

Table 2 shows the composition of some of the roughages commonly fed to feedlot cattle. Dry matter content of roughages is highly variable and is an important consideration when determining price. Alfalfa hay contains more energy, protein, calcium and phosphorus per ton than the other roughages listed and generally is higher in price. Corn silage, barley silage and alfalfa haylage contain more water and are less valuable nutritionally than alfalfa and brome hay.

Corn is the primary energy source for feedlot cattle and is the standard by which the other grains are compared. Soybean meal is a common protein supplement and is the standard by which protein sources are often compared.

The values in tables 3 and 4 were computed using corn and soybean meal to estimate the relative value of protein and energy. Dicalcium phosphate ($14.00/cwt) and limestone ($5.00/cwt) were used to determine the value of phosphorus and calcium, respectively.

First, the values of calcium and phosphorus in corn and soybean meal were subtracted from the price. Then the prices of corn and soybean meal, excluding the value of calcium and phosphorus, were used in the following two equations to determine the relative value of energy and protein:

\[
70 \times x + 10.1 \times y = \text{corn price (excluding Ca and P)}
\]
\[
63.52 \times x + 49.9 \times y = \text{soybean meal price (excluding Ca and P)}
\]

\[
x = \text{value of energy ($/Mcal)}
\]
\[
y = \text{value of protein ($/lb)}
\]

70 = Mcal NEg/100 lbs corn DM
63.52 = Mcal NEg/100 lbs soybean meal DM
10.1 = lbs crude protein/100 lbs corn DM
49.9 = lbs crude protein/100 lbs soybean meal DM

These calculations were repeated for corn valued at 2.00, 2.50, 3.00 and $3.50 per bushel and for soybean meal valued at 150, 200 and $250 per ton, respectively. The amount of energy, protein, calcium and phosphorus in each bushel of grain or ton of roughage was then multiplied by the respective value of energy, protein, calcium and phosphorus. Finally, the values of energy, protein, calcium and phosphorus were summed.
Tables 3 and 4 may aid cattle feeders in deciding which feed ingredients are the most economical to use. For example: if corn is valued at $2.50/bu and soybean meal is priced at $150/ton, barley is an economical feed grain when it is priced at $2.16 or less, corn silage is worth $22.47 per ton and alfalfa hay is worth $64.94 per ton.

Values in these tables assume optimum performance is achieved. If substituting one of these feed ingredients into a ration for another results in reduced performance, the added expense of the reduced performance should also be considered. For example, if barley replaces 100% of the corn in a finishing ration, cattle will likely require 10 additional days on feed. If yardage costs $.25 per hd per day, then an extra expense $2.50 per head is incurred.

**Cattle Information**

The proportions at which feed ingredients are mixed together to make up a ration depends upon the desired levels of nutrients in the ration. The nutrient level and energy density is dictated by the nutrient requirements of the cattle to be fed.

Nutrient requirements of cattle vary with many factors. The most important of these are: weight, sex, degree of flesh, environmental conditions and desired level of performance. In order to use the principles of least-cost formulation, these factors must be known when balancing the rations.

**Value of Feed Analysis**

The previous discussion relies heavily on a detailed knowledge of the nutrient composition of the various feed ingredients. The value of each feed ingredient depends upon the nutrient composition of that ingredient and the relative values of energy, protein, calcium and phosphorus. Errors in the estimation of the nutrient composition of a feed ingredient lead to erroneous prices being assigned to each feed ingredient.

Whether the concentration of a nutrient should be determined depends upon the variability in content and on the cost of analysis relative to the cost of supplementation. The calcium content of grains is very low and the variability unimportant. The cost of calcium analysis relative to the cost of calcium supplementation is high. The cost of supplementing a ration compared to the cost of chemical analysis is shown in table 5 and 6.

The most important analysis to perform is to determine the moisture content. Moisture content of certain feed ingredients, especially silages, varies tremendously and has the most significant impact on the energy content of the ration. If one wishes to feed finishing cattle a ration 75% high moisture corn (73% DM), 5% supplement (90% DM) and 20% corn silage (35% DM), one needs to use 62.1 lbs of high moisture corn, 3.4 lbs of
supplement and 34.5 lbs of corn silage for each 100 lbs of ration mixed. This ration would contain approximately 64 Mcal/100 lb DM. If the dry matter content of the corn was actually 65% and the dry matter content of the silage actually 40% and we mixed the ration according to the same as-fed formula, the energy content of the latter diet would be 62.9 Mcal/100 lb DM or 1.7% lower.

Protein determination is relatively inexpensive (tables 5 and 6) and accurate. If one wishes to formulate a concentrate portion of a ration with 14% crude protein and decides to use barley (12% CP) and soybean meal (44% CP), 6.25% soybean meal and 93.75% barley would be required. If the barley actually contained 13.5% crude protein, 92.2 lbs of soybean meal or $6.92 (SBM = $7.50/cwt) per ton of concentrate could be saved if the proper protein content of the barley was known.

Obtaining Feed Samples

Proper sampling procedures are absolutely necessary if analyses are to be useful. If proper samples cannot be obtained, it is better to use average feed analysis values found in composition tables. When sampling hays or grains it is important to obtain several samples from various random bales or locations. These samples should be composited and thoroughly mixed. Approximately one pint of grain or 1/2 gallon plastic bag of hay should be taken as the final sample for analysis. It may be necessary to sample silage several times during the feeding period especially if there is appreciable variation in the maturity, variety, or date of cutting of the silage. Take 15 or more double handfuls of silage from different locations, mix thoroughly and save about 1/2 gallon for analysis.

Summary

Least-cost ration formulation is a valuable tool to reduce feed costs in cattle feeding operations. Specific information concerning the availability and value of feed ingredients, type of cattle and the desired level of performance is required in order to utilize the principles of least-cost ration formulation.

Feed ingredients should be priced on the basis of their nutrient and moisture composition. In order to determine price, an accurate estimate of the nutrient composition is required. Analyses for protein and moisture are relatively inexpensive compared to the cost of supplementation and should be routinely practiced. Analyses for calcium and phosphorus are relatively expensive compared to the cost of supplementation and are of little value if performed more than periodically.
Table 1. Composition of Feed Grains

<table>
<thead>
<tr>
<th>Grain</th>
<th>Dry Matter Basis</th>
<th></th>
<th>Bushel</th>
<th>Per Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry matter (%) /lb</td>
<td>NEg (%)</td>
<td>CP (%)</td>
<td>Ca wt. (%)</td>
</tr>
<tr>
<td>Corn</td>
<td>88</td>
<td>70</td>
<td>10.1</td>
<td>.02</td>
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<tr>
<td>Barley</td>
<td>88</td>
<td>.64</td>
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<td>.05</td>
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<tr>
<td>Ear corn</td>
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<td>.62</td>
<td>9.0</td>
<td>.07</td>
</tr>
<tr>
<td>Millet</td>
<td>90</td>
<td>.64</td>
<td>12.9</td>
<td>.03</td>
</tr>
<tr>
<td>Milo</td>
<td>87</td>
<td>.64</td>
<td>10.1</td>
<td>.04</td>
</tr>
<tr>
<td>Oats</td>
<td>89</td>
<td>.55</td>
<td>13.3</td>
<td>.07</td>
</tr>
<tr>
<td>Rye</td>
<td>88</td>
<td>.64</td>
<td>13.8</td>
<td>.07</td>
</tr>
<tr>
<td>Wheat</td>
<td>89</td>
<td>.68</td>
<td>13.5</td>
<td>.04</td>
</tr>
</tbody>
</table>

a Adapted from Nutrient Requirements of Beef Cattle, NRC, 1984.

b Net energy for gain. Bushel weight x Dry Matter x NEg per pound.

c Crude protein. Bushel weight x Dry Matter x protein %.

d Calcium. Bushel weight x Dry Matter x calcium % x 454.

e Phosphorus. Bushel weight x Dry Matter x phosphorus % x 454.
Table 2. Composition of Roughages

<table>
<thead>
<tr>
<th>Roughage</th>
<th>NEg (%)</th>
<th>CP (%)</th>
<th>Ca (%)</th>
<th>P (%)</th>
<th>NEg (Mcal)</th>
<th>CP (lb)</th>
<th>Ca (g)</th>
<th>P (g)</th>
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<tr>
<td>Corn silage</td>
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<td>749.1</td>
<td>659.2</td>
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<td>Barley silage</td>
<td>31.20</td>
<td>10.3</td>
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<td>.25</td>
<td>124.0</td>
<td>63.9</td>
<td>844.4</td>
<td>703.7</td>
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<td>Brome hay</td>
<td>89.26</td>
<td>10.0</td>
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<td>.23</td>
<td>462.8</td>
<td>178.0</td>
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<td>Alfalfa hay</td>
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<td>Alfalfa haylage</td>
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<td>235.6</td>
<td>117.8</td>
<td>5,175.6</td>
<td>966.1</td>
</tr>
</tbody>
</table>

a Adapted from Nutrient Requirements of Beef, Cattle, NRC, 1984.
b Net energy for gain, 2000 x dry matter x NEg per pound.
c Crude protein. 2000 x dry matter x protein %.
d Calcium. 2000 x dry matter x calcium % x 454.
e Phosphorus. 2000 x dry matter x phosphorus % x 454.
Table 3. Relative Value of the Various Grains Compared to Corn for Feedlot Cattle

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<thead>
<tr>
<th>Grain</th>
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<th>3.00</th>
<th>3.50</th>
<th>price $/Ton</th>
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<td>1.93</td>
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<td>2.64</td>
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<td>Ear corn</td>
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<td>1.77</td>
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<td>2.48</td>
<td>200</td>
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<td>1.42</td>
<td>1.77</td>
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<td>2.48</td>
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<td>Millet</td>
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<td>1.70</td>
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<td>1.71</td>
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<td>Grain</td>
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<td>Soybean meal price $/Ton</td>
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<tr>
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<td>150</td>
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<td>31.09</td>
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<tr>
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Table 5. Cost of Feed Analyses\textsuperscript{a}

<table>
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<tr>
<th>Item</th>
<th>Price, $</th>
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<tbody>
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<td>Moisture</td>
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</tr>
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<td>Crude protein</td>
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</tr>
<tr>
<td>TDN</td>
<td>12.50</td>
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<tr>
<td>Calcium</td>
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</tr>
<tr>
<td>Phosphorus</td>
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</tr>
</tbody>
</table>

\textsuperscript{a} Analytical services provided by the Station Biochemistry section of the Chemistry Department, South Dakota State University, Brookings.

Table 6. Cost of Analysis Relative to Cost of Supplementation

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost/Ton\textsuperscript{a}</th>
<th>Tons supplemented for complete ration</th>
<th>Cost of one analysis</th>
</tr>
</thead>
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<tr>
<td>Phosphorus</td>
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<tr>
<td>Protein</td>
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<td>.25</td>
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\textsuperscript{a} Dicalcium phosphate at $14.00/cwt, limestone at $5.00/cwt and soybean meal at 200/ton.