by Steve Martin

Ration formulation has come a long way

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HAVING never used a slide rule, I am not exactly sure how it would work. I assume, though, that this math is now done with computers.

Martin

I had something similar to a slide rule at the beginning of my nutrition career. Upon starting a new job in 1991, I was given a box of materials. In the box was a thick cardboard tool with a sliding part in the middle and windows showing different levels of milk production and types of forages. When sliding the middle part up and down and lining it up to represent a farm, in another window it suggested the best feed product.

Wow, we have come a long way in ration formulation! However, are you sure your ration is formulated to take full advantage of the combination of biological modeling and linear programing?

My favorite term for formulation is "building rations." In this process, we intersect the principles of biology and economics. Yes, we can use our experience, but we must accept that the model does math that we can't do, even in a spreadsheet. Linear programing is the tool that allows the computer to find the best solution using available ingredients to meet nutritional needs.

Most formulation software platforms have two ways to build a ration. The first allows the user to input ingredients and adjust them up and down until the desired nutrient levels are met. It is a trial-and-error approach where the experienced formulator can meet the animal's needs, manage feed cost, and produce a diet consistent with past successes.

The second way is to describe the animal to the software and offer available ingredients and the cost of each. You still get to use your cow-sense by putting minimum and maximum ranges on each ingredient. After a few more details, you let the model help you find the best solution. It is true that the computer is smarter than you. However, the computer needs the user's experience and wisdom for this to be successful.

Let's talk milk protein

Let's look at some different situations where the linear program offers the best chance for success. With varying prices for milk components, at times, rations should be built to support higher protein content in the milk. There are several nutrient levels that can be emphasized to reach these goals.

If milk protein prices are high, how should the ration be built to capture extra income? Our mind first goes to the protein side of the diet, striving to be sure that we have met the needs for certain amino acids. With a multitude of products supplying lysine and methionine, which amino acid supplement should we choose and how much should we feed? How about the inclusion of the commercial product impacting the other ingredients in the ration like soy and canola that also supply these amino acids?

Using the linear program, the nutritionist can let the model decide what is the lowest cost approach to meet the increased demand for the building blocks of milk protein. This is math you can't do in your head. It is also an approach that is better than simply picking an amino acid product and adding it to the current ration.

Additionally, managing starch dynamics in the rumen and maximizing microbial protein synthesis can't be ignored. The model can do this the best.

Butterfat is similar

The situation is similar when milkfat economics encourage us to build rations to maximize butterfat. This process is a little less intuitive and not only focuses on adding milkfat building blocks to the diet, but also includes limiting another nutrient (linoleic acid) that inhibits milkfat synthesis. We can use the linear program to do both at the same time!

Fernando Diaz and his colleagues detailed a meta-analysis of the effects of linoleic fatty acid intake on lactating dairy cow performance. The report in the *Journal of Dairy Science* indicated a linear reduction in milkfat in numerous studies as unsaturated fat levels rose in the diet.

Knowing this, I can use the model to add a maximum nutrient level for linoleic acid. Since you can ask the model to solve for several nutrients at once, I can also require a minimum level, type of fiber, and maximum level of starch. All of this can help the fat test. If you have offered the necessary ingredients, the best and lowest-cost solution will result.

You can also test the cost sensitivity of even lower limits of unsaturated fat to further enhance butterfat. As you lower the maximum allowable level of linoleic acid from sources like distillers grains, feed cost will go up. You can decide if the extra cost can be overcome by higher milk fat revenue.

The last situation is a bit more straightforward. Consider the option to pay more for higher quality alfalfa hay or the choice between different by-products like gluten or soy hulls. The better hay isn't always the right choice, and we can't simply value by-products as a percentage of corn price or use cost per unit of protein to decide between soy and canola. Ingredients must be considered in a holistic ration approach. The answer often surprises you.

Some have been discouraged by linear programing and feel more comfortable entering diets and adjusting feed rates to meet nutrient and cost goals. After having the model's solution suggest that you feed 15 pounds of cottonseed or 3 pounds of urea, some give up. Likewise, when putting tighter limits on ingredient feed rates, infeasible solutions are often the result.

These hurdles can be overcome with the correct approach, and the result will be better rations that meet more specific goals for the lowest input cost. This approach offers the producer the best opportunity to convert feed dollars to milk income at the highest rate

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