Nutrient driven dairy cow performance

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There are two common systems for delivering feed nutrients to dairy cows today – one is ingredient based, the other nutrient based.

In an ingredient based system a nutritionist works with the farm operation to understand the cow housing and feeding environment, tests the forages, and uses a ration formulation model to determine a set of nutrient requirements needed.

Often the same model uses 'book values' for ingredients and then presents the nutritionist and dairy manager with a list of ingredients that are intended to meet the nutrient needs of the animal.

The list of ingredients is then put up for bid and a decision is made to purchase the list of ingredients from the supplier presenting the best value. The challenge is that nutrient variation within ingredients means the nutrients delivered are usually not the same as originally intended.

A nutrient based system for delivering feed nutrients to the dairy business may look like the following – a nutritionist works with the farm operation to understand the cow housing and feeding environment, and tests the forages at a forage laboratory that is part of the overall nutrient delivery system.

The ration formulation model determines a set of nutrients needed and matches it up with ingredients of a known nutrient composition.

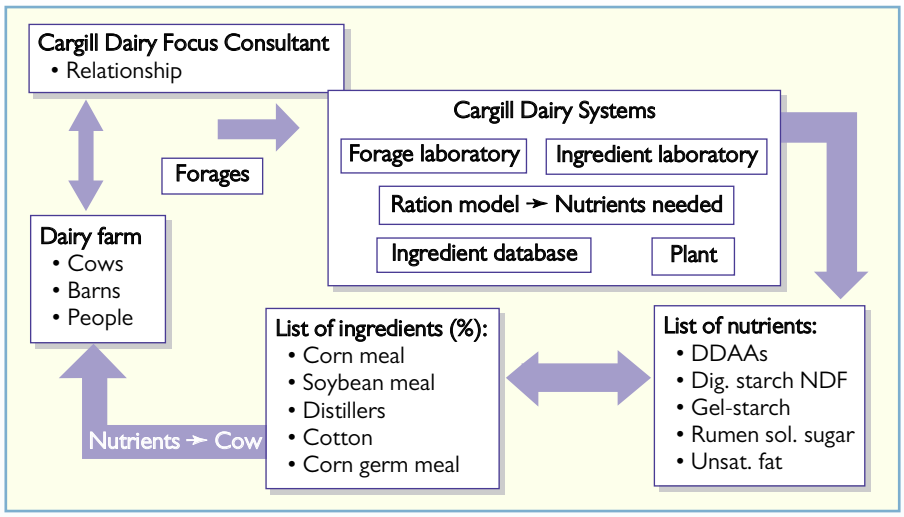


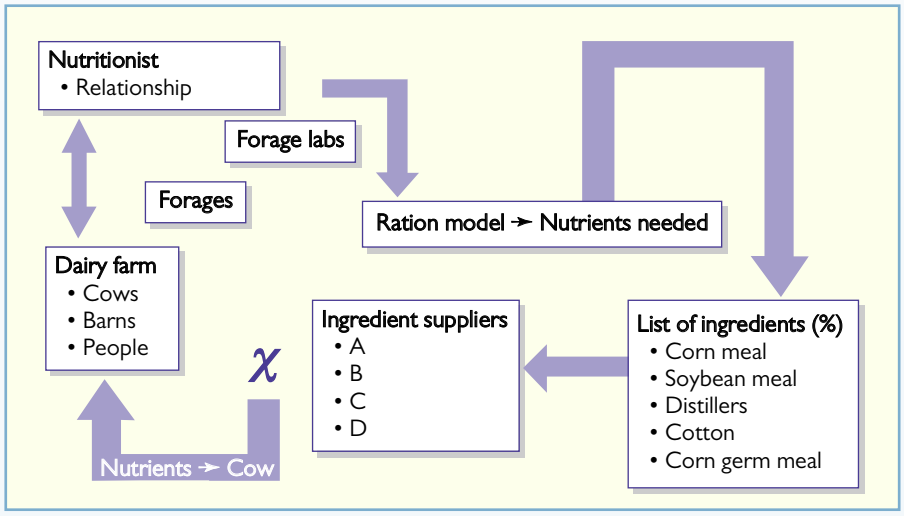
Fig. 1. A nutrient based feed delivery system.

The product formula, containing nutrients and ingredients, is presented to the feed manufacturing plant. The plant conducts ongoing analysis of ingredients by supplier for key nutrient variation.

This allows future updates to the product to ensure nutrient consistency, even if nutrient content of ingredients change.

The process of determining a set of ingredients to meet nutrient specifications, with opportunity for review, is repeated for each load of feed. The ingredients may change within a determined percentage, but the nutrients delivered to the farm are consistent from load to load.

Fig. 2. An ingredient based feed delivery system.



Digestible fibre

Additionally, laboratories have not used a consistent measurement to quantify neutral detergent fibre (NDF) content or digestibility. When a consistent measure is used, digestible NDF of the diet can have a significant impact on production. In a recent field study, the same set of diets was analysed by two different methods for digestible NDF and correlations were made to bulk tank averages.

A commercially available in-vitro analysis of digestible NDF (Fig. 3) was less consistent in accounting for the variation in bulk tank average than a near infrared (NIR) determination (Fig. 4) that is calibrated to several wet chemistry measures of digestible NDF.

While the measure of digestible NDF in Fig. 3 may 'pick up' more variation, the significance of the measurement is questionable since there is no correlation to milk production.

The measurement in Fig. 4 does not show the diets varying as much in digestible fibre,

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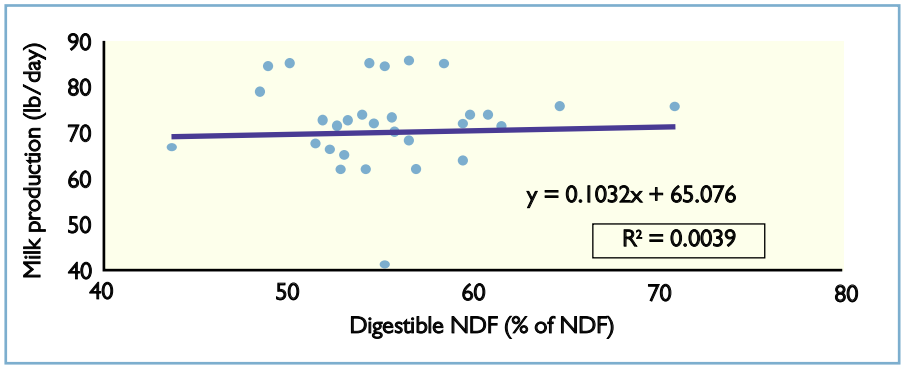

Fig. 3. In-vitro analysis of digestible NDF.

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yet there is a much stronger relationship to bulk tank average. It holds more promise to farm business managers and nutritionists as a tool for improving diet formulation than the measure of digestible NDF in Fig. 3.

Amino acids

Cows do not need crude protein. Cows require the building blocks of protein called amino acids. Dairy cattle absorb amino acids through their small intestine. They get about two-thirds of the amino acids from the microbial mass (bacteria and protozoa) grown during rumen fermentation and then washed out from the rumen into the small intestine. The other one-third of amino acids is supplied from the release of feed protein hitting the 'sweet spot' of making it though the rumen without being consumed by rumen bugs, but available enough to be absorbed through the small intestine.

At the same time these feed amino acids also must not be so resistant to breaking down that they pass through the animal altogether.

Nutrient models must do three basic things to properly meet amino acid requirements of dairy cows:

- Determine the amino acid requirement.
- Estimate amino acids produced by the diet through the growth of rumen microbes.
- Estimate the amino acids in the feeds that bypass the rumen, will be absorbed in the small intestine, but will not pass through the animal undigested.

Nutrient models use research studies to determine amino acids required for each function at a tissue level. The efficiency at which amino acids are absorbed and used is also determined. Nutrient models can differ significantly in their amino acid requirements based on the research used to build the models.

Nutrient models differ in how reliably they predict the amount of amino acids produced from rumen microbes. Models must determine rumen available energy and nitrogen provided by the diet. Models then moderate the fermentation by other factors including acidity, chewing time, buffering and effective fibre. Dry matter intakes are used to determine the rate microbes are washed out of the rumen. These microbes are a source of 'animal protein' with high amino acid content. Nutrient models differ in how much washout there is and in the amino acid value of the rumen microbes.

In taking advantage of unique, more defined nutrients some models use different, specific values of rumen available energy for sugar, gelatinised starch, native starch, pectin and digestible NDF for each forage and feed ingredient, and then sum them to predict total rumen available energy. This refined prediction of rumen available energy results in an improved estimate of amino acid contribution from the rumen. Chewing time associated with individual ingredients, buffering and rate of carbohydrate release can be used to predict rumen pH, which will modify rumen function and further refine the prediction of rumen produced amino acids. Such models present an opportunity to economically improve dairy performance.

Detailed feed libraries are needed to know the amino acid content of different feed ingredients. Ongoing analysis and prediction technologies are also needed to keep up with the variation of amino acid content of forage and feed ingredients. Research on the release rates of amino acids is used to predict the amino acids that hit the 'sweet spot' of making it though the rumen without being consumed by rumen bugs, but available enough to be absorbed through the small intestine.

It is almost always more cost effective to meet amino acid requirements through maximising the rumen fermentation supply. It is next best to rely on feed ingredients. Interruptions in normal rumen function and variation in forage and feed ingredients can make it difficult to predict the amino acids supplied by a diet. Sometimes it is necessary and economically beneficial to use feed ingredients with 'rumen protected' amino acids that will be absorbed in the small intestine to make sure there are enough amino acids to meet requirements.

Some nutrient models have detailed feed ingredient libraries that can accurately predict individual amino acid release by feed ingredient using a quick measure of rumen undegradable protein. Such models present an opportunity to the nutritionist and dairy manager because they can rapidly and cost effectively provide a more consistent prediction of amino acid supply. By having a better prediction model, less expensive ingredients and a narrower 'safety factor' can be used to reliably meet amino acid requirements. ■

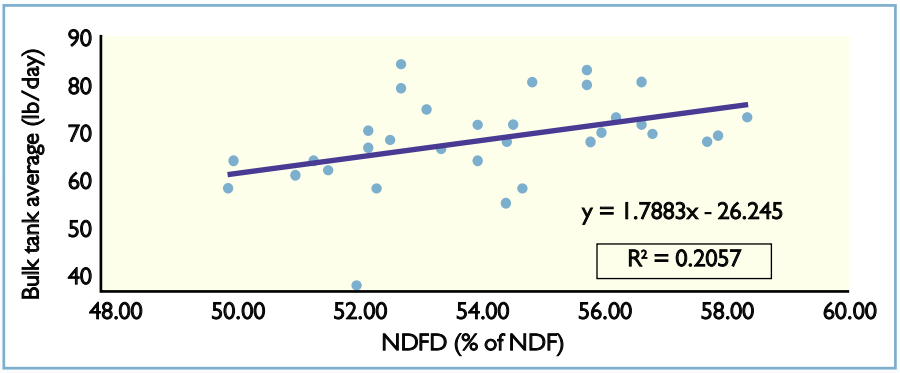

Fig. 4. A near infrared (NIR) determination of digestible NDF.

Cargill's animal nutrition dairy business process.