



Ration Balancing : New Advances in Dairy Research

As advances in dairy cattle nutrition research are now becoming available to the dairy industry, it is sometimes difficult to understand how these different advances and improvements in our understanding of dairy nutrition with the different approaches taken by different companies and their associated “jargon”. This brochure is meant as a general overview of the different ration balancing systems that are available to Ontario dairy producers and the level of our understanding and use can be for each one.

Up until 10 years ago, most dairy nutrition research was based on evaluating dairy cow health or production responses to different nutrient (protein, energy, calcium etc..) or ingredient (alfalfa haylage, cottonseed, distillers grain etc..) levels in the ration. Based on the results from these trials, our understanding and conclusions of animal response to specific diets were confirmed or questioned. The present National Research Council (NRC) standards are based on a compilation of many individual research trials that were used to establish accepted protein, energy, mineral and vitamin requirements for dairy heifers and cows at different stages of growth and production.

NRC based **ration balancing programs** use formulas to determine the most cost-effective mix of ingredients available on a farm to best meet the cow’s specifically calculated requirements. These programs are not nutritional programs, they arrive at an answer that may not be nutritionally correct. For example, a ration balancing program might suggest that 24 kg of haylage be fed with no corn silage, despite the fact that a producer has 2 silos with haylage and corn silage each and both must be fed at 50:50 ratio. Most programs allow for this type of constraint to be inputted into the initial parameters so that the computer balances a ration that is a “best cost” scenario vs. “least cost” using the real farm conditions to arrive at a balanced ration. The computer ration balancing program is nothing more than a complex calculator, and cannot tell us the nutritional consequences of a certain ration, nor how feasible the ration is for a particular farm situation.

Ration evaluator programs allow the user to input the different ingredients fed to a cow during a day and then computes the total nutrients that are delivered with the inputted ration. The program then compares the consumed ration and “evaluates” how the ration compares with expected cow nutrient requirements. Some of these programs can also be used as ration balancing programs as well.

Over the past couple of years, some feed companies have been offering amino acid based rations or “rumen-modeled” rations to their customers. These rations are promoted as predicting diets that are short in a specific amino acid or suggest specific ingredient blends to optimize the “amino acid balance” of a ration. It is important to understand the context of these statements and realize what the benefits / limitations are for these nutritional amino acid programs and how applicable they are to your dairy operation.

Nutrition models are programs that use mathematical formulas to mimic a biological system, in this case a cow's rumen. In this system the inputted ingredients are entered into the model which then predicts the rumen microbe response to the specific ration and estimates the animal response in terms of rumen health, milk production, or efficiency.

Balancing for nutrient requirements with an NRC based ration balancing program makes several assumptions that are important to understand when comparing with a nutritional model :

- ?? When ration balancing, we are balancing for the average cow in the group, or a "standard" cow for a certain level of production. Obviously not every cow in the high group weighs 680 kg, is in her 3rd lactation, and is currently giving 41 kg of milk at 75 days post calving. This lack of precision with the NRC is usually more than compensated for with individual cows in the group variation above and below the inputted average.
- ?? The inputted **Dry Matter Intake (DMI)** is fundamental to determining the concentration of nutrients required in the total diet and the level of each ingredient to be fed. There are no recommendations made for specific ingredients.
- ?? No account is made for cows with different genetics or living in different housing conditions (tie stall vs. freestall, well ventilated barn vs. poorly ventilated)
- ?? No genetic differences between cows are taken into account with requirements
- ?? Feeding management and health status of animals is ignored
- ?? The program looks at the animal as a whole and does not take into account the role of different rumen digestion rates of different ingredients and the effect of efficient vs. sub-optimal feeding of the rumen bacteria with different feeding strategies and systems.

Despite these limitations, the NRC system has several advantages :

- ?? It is a nutrition system that has been proven over time to give reliable predictions of performance for herd averages, provided proper nutrient analyses are entered and an accurate DMI is used.
- ?? The NRC system has proven results on a wide variety of different ration ingredients and nutrient levels. Many of the top herds in Ontario are being fed from programs that are based on NRC requirements and nutrient specifications.

Analyzing for specific amino acids for a feedstuff can be done, but is more complicated and not like determining calcium content in a forage sample. Determination of the amino acid content of a sample would cost at least \$400.00 for each ingredient ! When a diet is amino acid balanced, we mean that the estimated levels of essential amino acids which enter the small intestines of the cow from the rumen are believed to be optimal for what the cow requires for different growth and production levels.

This approach of estimating the quantity and quality of the amino acid flow of food passing from the rumen to the last stomach of the cow is a completely different approach than is used in a NRC based ration balancing program. The rumen models are a biological model that attempts to mimic rumen fermentation by using complex mathematical functions to account for different rates of rumen microbial digestion of different ingredients and their effect on microbial protein production. The model then makes an estimate of the total protein flowing to the cow's intestines, including the relative proportion of essential amino acids available to the cow. The model works completely opposite from ration balancing programs, in that it evaluates the rumen function and predicts what level of cow performance will result from the inputted ration. The original model was called the Cornell Net Carbohydrate and Protein System (CNCPS) and updated versions of the basic idea of nutrition models (Penn State model, CPM model) serve as predictive models for the rumen only. The programs do not account for what happens to nutrients after they are passed to the cow's intestines or how they are absorbed by the cow. The models use several assumptions to predict animal performance, based on the protein and amino acid flow to the intestines and their known influence on growth, milk and component production. The latest model developed at the University of Guelph, supported completely by Purina now looks at absorption of the amino acids by the cow's organs and determines the absolute quantity and quality of amino acids that are available to the mammary gland for milk protein production.

Some nutrition companies presently offer amino acid balanced rations, but use standard amino acid profiles for different feedstuffs, which are then added together, like calcium or soluble protein in a NRC based ration balancing program. This is not a model, because different mixes of ingredients will result in different levels of rumen efficiency, which will yield different levels of amino acid being produced from the rumen. These programs, can be an improvement over NRC based ration balancing programs which only balance for crude protein or different protein fractions, it is important to remember they do not take into account different ingredient digestibilities and rumen microbial efficiencies. These rations can be used as general guidelines for a ration, but should not be over - interpreted. They are really NRC-based rations with extra equations to balance amino acids with the same mathematical formulas we use for traditional nutrients like protein, energy and minerals. These formulas are based on cost and are not meant to imitate the rumen or predict performance.

In order for the nutritional models to be accurate, it is important to have special analyses performed on the feed ingredients that are part of the ration. These analyses are different from standard forage analyses and include determination of the lignin, non-protein nitrogen (NPN), acid detergent insoluble nitrogen (ADIN), neutral detergent insoluble nitrogen (NDIN), and starch values. The above analyses are supplemental nutrient parameters that are essential in running a rumen nutritional model. Another common misuse of nutritional model is to assume that all nutrient parameters that are in the program database are representative of our feedstuffs here in Ontario. A research trial that was presented at the Guelph Dairy Science meeting showed that diets that were formulated using bookvalues showed a significant drop in performance compared with rations where ingredients are accurately analyzed and inputted. While the major grains fed to dairy cattle do not vary

extensively, by-product feeds and expensive by-pass protein sources can vary greatly with source, processing and time of year. Using bookvalues for these ingredients can lead to faulty assumptions and rations that do not accurately reflect their ingredient makeup.

Ideally, these models should be used to evaluate the present ration and existing herd performance. If the model predicts a different production than is seen in the herd, it should be modified and re-run until it accurately predicts what is actually happening in the herd today. Once this is done, then different ingredients or ration scenarios can be inputted and the model prediction should be accurate. This is the strength of nutritional models and offers nutritionists and producers to make greater improvements in herd performance and nutrient efficiency when applied correctly, without going through potentially expensive and time consuming on-farm trials with new ingredients or commercial supplements. The Penn State model and newer CPM model, offer the opportunity to “optimize” or balance rations, based on different nutritional parameters that the model predicts. While this allows a further refinement over traditional NRC based ration balancing programs, if no attempt is made to make the model mimic what is presently happening on the farm, the final answer can be misleading.

Some producers use these nutritional models to balance rations because of this specialized nature of the model and the inherent “appeal” of being part of the latest in nutrition technology. When rations are inputted without making sure all of the traditional aspects of a feeding program are taken care of such as maximizing dry matter intake, proper delivery of feeds to the cows, making cow comfort a priority, and having the herd production above 10 000 kg, the model is not ideal for those situations. Remember, the model only imitates the rumen - we still need to focus on maximizing all of the other factors associated with optimizing milk production in dairy cows. If a shotgun approach is used for balancing rations with the model, the final ration can also be further misleading if bookvalues are used for ingredients available on farm. If improper ingredients are inputted into the ration the final result can also be more expensive, with the large potential to not deliver the predicted animal response.

Ration balancing can be a relatively simple procedure for many dairy operations. What ration balancing option is right for your herd ? Use the simple outline below to help you decide what option is most appropriate for your herd :

- ?? Do you know what the average dry matter intake is in your herd for cows at peak milk and mid-lactation ?
- ?? What is your present herd production? What are your goals for production ?
- ?? Have you maximized cow comfort issues in your barn ? What other improvements can be done to improve the comfort and environment of the herd?
- ?? What sort of feeding system do you have ? Unless you are feeding a true TMR, meaning all ingredients are mixed together, it is unlikely that you will get all of the potential benefits from a nutritional model.
- ?? What are you willing to spend for nutritional costs for the herd? While a good point can be made for increasing the efficiency of the cow's nutrition by providing the best mix of ingredients that matches the rumen microbes requirements, additional ingredients required to supplement microbial protein to provide optimal

nutrition for the cow are often more expensive and can increase purchased feed costs.

?? Even the best modelled ration cannot replace excellent quality forages and quality supplements or commodities that are consistent and not over processed. How is your forage management ? Are there any improvements that could be made to maximize the quality of forages you harvest on your farm?

Ration balancing is an important aspect to successful feeding management of a dairy herd. Using the best information on ingredients and cow profiles makes balancing a ration more realistic and ensures better cow performance.