Update on Development of the Spartan Dairy Ration Evaluator/Balancer Version 3

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Abstract

Version 2 of the Spartan Dairy Ration program was widely used because it was user-friendly and gave reasonable diets relatively quickly. In Version 3 of Spartan Dairy, we have tried to retain those aspects of Version 2 which made it successful, while also incorporating the best science for on-farm nutrition. The nutrition model is largely based on the 2001 version of the Nutrient Requirements of Dairy Cattle by the National Research Council **(NRC)**. The 2001 NRC made fundamental changes in the submodels for energy and protein. The NRC was designed as an evaluation model, and some of these changes created challenges for a user-friendly program that was designed for routine use in formulating diets on dairy farms. Version 3 of Spartan Dairy incorporates the 2001 NRC system as written, as well as modifications that enhance its use in ration formulation and state-of-the-art features for a Windows application.

Nutrition Model

The team working on Spartan Dairy 3 includes Mike VandeHaar, Robert Kriegel, Dave Beede, Herb Bucholtz, and Mike Allen. Robert Kriegel is the programmer. Spartan Dairy 3 is largely based on the 2001 Dairy NRC. A critique of the nutrition model of the 2001 Dairy NRC and challenges in using this model in ration evalution were presented at the TriState Dairy Nutrition Conference in 2002 (VandeHaar, 2002).

Energy

The energy system of the 2001 Dairy NRC is considerably more complicated than that of the 1989 NRC. The 2001 NRC was developed to be a retrospective evaluation program. Whereas a retrospective program examines a diet that has already been consumed by a cow and thus is at least reasonable, the prospective ration formulation program must be able to develop a new diet without prior knowledge of how the cow will eat it. Estimation of feed energy values using the composition of ingredients is likely an improvement over the previous system of book NE_L values. However, protein is overvalued in the model, with an energy value of 5.6 kcal/g of digested protein but with the same constant conversion of digestible energy **(DE)** to metabolizable energy **(ME)** as in 1989. More importantly, the digestibility discount is now adjusted for level of intake, and, although feed factors are not used in predicting feed intake, they are used in predicting digestibility. Nonfat feeds with the highest total digestible nutrients **(TDN)** values at 1X maintenance are discounted the most with increasing intake. As an evaluation program, this may work well. However, as a formulation program for high producing cows, the new system predicts nearly the same energy-allowable milk with a high grain diet as with a high forage diet. Because the feed intake equation does not use feed factors, the implicit assumption is that a cow can eat as much of a high forage diet as a high grain diet. Thus, least-cost formulation programs would be unjustly

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biased toward high forage diets for high-producing cows. As a diet formulator, the 2001 NRC model favors diets for high producing cows that are higher in fat, protein, and fiber than are optimal for high production.

Whereas Spartan Dairy 3 includes the energy system as designed in 2001 NRC, it also includes a revised energy system. Key features of the revised system include a lower energy value for digested protein, using protein fractions to calculate the amount of digestible protein instead of acid detergent insoluble crude protein **(ADICP)** and separate tables for specific feeds, and the removal of feed factors from the equation for predicting the digestibility discount. Requirements for energy in the new Spartan program are largely as written in the 2001 NRC, but include revisions to the requirements for work and also include adjustments for environmental temperature and Rumensin (Elanco, Greenfield, IN).

Protein

The protein system of the 2001 Dairy NRC also is considerably more complicated than that of the 1989 NRC. On the requirement side for NRC, the metabolic fecal protein requirement was decreased, a requirement for secreted gut proteins was added, the protein requirement for pregnancy increases with day of gestation, and the protein required for growth or body condition gain is affected by body weight **(BW)** as a percentage of mature BW and the actual body condition score of the animal. On the supply side, the fraction of protein that is rumen undegradable protein **(RUP)** is a function of its protein fractions (A, B, and C) and the competition of digestion and passage for fraction B. All of the C fraction is assumed to be RUP, and all of the A fraction is assumed to be rumen-degraded protein **(RDP)**. The RUP value of the B fraction depends on its digestion rate (k_d, which is a fixed value for each feedstuff) and the passage rate (k_p) for the feed. In addition, the percent of RUP that is digested is no longer assumed to be 80% for all feeds but is a fixed value for each feedstuff. The supply of metabolizable protein from microbial protein is a function of the fat-corrected, discounted TDN intake of the animal. As in 1989, microbial crude protein is considered to be 80% true protein and 80% digestible. The equation for microbial protein yield has no intercept, so it works much better for young heifers. Finally, the new NRC also considers amino acid requirements and supply.

As with energy, Spartan Dairy 3 allows the use of the NRC system but also provides an alternative. In the Spartan Dairy protein system, requirements are largely as in NRC, but slight changes were made in requirements for pregnancy, work, and thermoregulation. The equations for microbial yield were altered, and microbial yield is slightly greater with the Spartan system than with NRC. Finally, the equations for the supply of lysine and methionine were altered slightly; and methionine supply is generally greater with the Spartan equations.

Feed intake

In the 2001 NRC, expected feed intake for lactating cows is predicted from metabolic body weight, fat-corrected milk yield, and days-in-milk. Expected feed intake is predicted from body weight, lactation number, and days-til-calving for dry cows and from metabolic weight and dietary energy density for heifers. Predicted feed intake is not altered by activity, growth rate, temperature, or ionophore. Thus, increasing the work level of a cow can greatly increase the required energy density in her diet if the predicted intake is used for formulating a diet. In Spartan 3, the equation for predicting feed intake is consistent across all animals and is based on metabolic body weight, energy-corrected milk yield, and energy requirements for daily gain, pregnancy, and work, with adjustments for days-in-milk, days-til-calving, temperature stress, and ionophore feeding. In most cases, the

dry matter intake **(DMI)** predicted by Spartan 3 is slightly higher than that predicted by NRC or Spartan 2.

Other nutritional features

In addition to the new equations of the Spartan 3 system, the Spartan 3 program also provides the user with values for energy and protein supply from the 2001 NRC and the Spartan 2 (1989 NRC). Dietary fiber fractions included neutral detergent fiber **(NDF)**, effective NDF, forage NDF, and soluble fiber. The user may do an accounting of carbohydrate fractions. Minerals are balanced on a total or absorbed basis.

The User Interface

Spartan Dairy 3 was designed from the start as a Windows application. It is a stand-alone program that will run best on a Windows XP operating system (or later). The program uses a spreadsheet interface similar to that of Spartan 2. All data are stored in MS Access database files. Several rations and feed library windows may be open simultaneously. Feeds can easily be copied and pasted from one file to another, and from or to MS Excel files. The program includes an optional transcript window that lists a complete audit trail of equations and calculations for the advanced user who wants more information.

Progress

Currently a working version of the program is undergoing testing; this program includes the feed library, animal description, animal requirements, and ration worksheet. Rations can be balanced manually, but further enhancements are being made to improve the user-interface and performance. The program lacks dialogs for reports and printing, user set-up, help, and the linear program. We are currently on target to release a product for sale by July, 2007. Updates will occasionally be posted on our website (www.msu.edu/ssl).

References

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