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THE SHIELD PROJECT

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Nutritional management of dairy cows has advanced rapidly in the past few years. The days of balancing rations with a pen and a piece of paper, while referencing NRC standards, should be well behind us. However, for a number of reasons, dairy cattle nutrition remains an art as much as a science. As more is known, the boundaries of what needs to be known expand. There seems to be little question that nutritional principles have raced ahead of techniques, particularly the analytical techniques required to support and test them. Hence the art. Nevertheless, much is known and representations of this information in a unified format, often called a model, can be helpful in bringing together what is known so that biological complexities can find their way into practice.

SHIELD is a mathematical model that attempts to synthesize known knowledge of dairy cattle nutrition with what is believed to be true, in order to create a tool that has practical application for dairy cattle nutritionists and nutritional professionals. Thus the amount of information required as model input is minimized, and restricted to that which a dairy farmer can reasonably be expected to provide. Expected input information on the cows, their environment, and feeds are all obtainable from animal performance records, cow observations, measurements of the environment and currently available feed assays.

SHIELD has been in development since about 1980. Originally published as the New Brunswick Protein Program (NBPP) in 1992, it was subsequently renamed The Atlantic Protein System (TAPS) in 1995. There were substantial changes to the program associated with this name change that related to calculations of intestinal delivery of protein and animal requirements for dietary protein fractions. In addition, amino acids were added. Early in 1998 the program was renamed SHIELD(DOS). This name change was associated with a substantial increase in the numbers of feedstuffs included in the feed dictionary in order to make it more reflective of all feedstuffs utilized in dairy rations. This current version of SHIELD(2016) is an Excel spreadsheet that has been updated with internal links to make navigation within the spreadsheet simple.

SHIELD(2016) is now available for purchase at:

www.animalscience.edu/extension/shield.htm

PURPOSES OF SHIELD

SHIELD is designed to be used in one of three ways:

In Ration Formulation

It should be the second step in a process whereby another program such as 'PC Dairy', available through UC Davis Cooperative Extension, is first utilized to formulate the ration for all nutrients including energy, protein, minerals and vitamins. This ration can then be used as input to SHIELD for an evaluation of its energy, protein, amino acid, mineral and vitamin status. This approach utilizes SHIELD to determine the biological feasibility of a ration that is proposed to be fed to a group of lactating dairy cows.

In Ration Evaluation

Any known ration that describes known performance of an actual group of cows can be evaluated for its energy, protein, amino acid, mineral and vitamin status. This approach utilizes SHIELD to identify nutrients that potentially limit performance, as well as nutrients that appear superfluous to requirements and may be removed from the ration to increase the efficiency that the remaining nutrient is used for production of saleable products. It can also suggest limitations of SHIELD itself by identifying rations that SHIELD predicts to be infeasible that, based on measured animal performance, occurred.

In Teaching

SHIELD can be used in a teaching format, either with University students, groups of dairy producers or nutrition professionals. In such a forum, SHIELD can be used to demonstrate the dynamic aspects of dairy cattle nutrition and how characteristics of the cows, feedstuffs and environment interact to lead to a likely production outcome. Individuals can also use SHIELD to investigate the impact of various feeding and management scenarios on animal performance.

FEED INPUTS

Measurable characteristics of feeds, which the user is expected to enter as many of as possible, are used to estimate other characteristics of the feeds as well predict animal response parameters. Although all feeds have a complete set of default values in the feed library, the more information that can be provided for the specific feeds used in the defined ration, the more accurate will be the overall evaluation.

User Provided Information

Analyzable characteristics of the feeds for which there is an expectation that the user could and should enter as many values as possible include the intake level of each feed (% of total ration DM), DM (%), OM (% of DM), Fat (% of DM), CP (% of DM), SP (% of CP), ADIP (% of CP), NDF (% of DM), dNDF (% of NDF), Ca, P, K, Mg, S, Na, Cl, Fe, Mn, Zn, Cu, Se, I, Co, and vitamins A/D/E.

Program Predicted Information

There are a number of characteristics of feeds for which there is no expectation that the user will enter values. This may be because the assay procedure is very expensive, difficult to access, unreliable or not available at all. However if actual values are available, the calculated values can be superceded. These include peNDF (% of NDF), NEl (3xM) (Mcal/kg of DM), UIP (% of feed CP that escapes the rumen undegraded), dUIP (% of UIP in the feed that is digestible), NFC (% of DM), energy discount (% of NEl for each increase of energy intake equal to the maintenance energy requirement), NEl (act) (net energy for lactation at the actual intake level specified in Mcal/kg of DM), amino acids (% in the CP in that feed that escapes the rumen intact), total and absorbable amino acids delivered to the intestine (g/d from that feed).

ANIMAL INPUTS

Measurable and observable characteristics of cows, which the user is expected to enter as many of as possible, are used to estimate other characteristics of the cows and evaluate their estimated nutritional balance of energy, protein, amino acids, minerals and vitamins.

User Provided Information

Milk yield, milk fat %, milk protein %, body weight, body condition, body locomotion, daily walking distance, lactation number, average days in milk, minimum days in milk, days pregnant, and expected calf birth weight.

Program Predicted Information

Maternal growth, fetal growth, net maternal BW change.

DRY MATTER INTAKE PREDICTORS

Predictions of Maximum Dry Matter Intake

Maximum daily DM intake allowed by the composition of the ration (kg/d).

Adjustments to Maximum Predicted DMI

Adjusters to DMI known to reflect animal or environmental factors that, in general, cause actual DMI to be lower than the maximum allowed by the composition of the ration. These include the parity of the cows, days in milk, days pregnant, locomotion score, humidex, ration DM %, and ration fat %.

PROTEIN/ENERGY REQUIREMENTS SUMMARY

Total CP required and consumed (g/d), degraded intake protein (DIP) required and consumed (g/d), total soluble protein (SP) required and consumed (g/d), total insoluble DIP required and consumed (g/d), digestible rumen undegraded crude protein (dUIP) required and consumed (g/d), intestinal flow of CP originating from peptides solubilized

in rumen fluid (g/d), net energy of lactation (NEl) required and consumed (Mcal/d), NDF minimum, maximum, optimal and consumed (kg/d).

Intake of Net Energy for Lactation

The estimated intake of net energy is calculated as the proportional intake of each dietary ingredient (on a DM basis) multiplied by its actual NEl value in Mcal/kg.

Requirements for Net Energy for Lactation

Milk, maintenance, exercise, urea excretion, maternal growth, heat dissipation, BW gain, BW loss, and gestation.

Delivery of Absorbable Protein

The calculated intestinally absorbable delivery of amino acids from feed UIP, rumen microbes and rumen peptides are summarized from previous calculations.

Requirements for Absorbable Protein

Maintenance, milk, BW gain, BW loss, maternal growth, and fetal growth.

Total and Absorbable Amino Acid Delivery

Intestinal delivery of any amino acid from rumen bacterial origin (g/d), intestinal delivery of any amino acid from rumen protozoal origin (g/d), intestinal delivery of any amino acid from rumen solubilized peptides that wash out of the rumen (g/d), intestinal delivery of any amino acid from feed CP that escapes the rumen intact.

Absorbable Amino Acid Requirements

Scurf AA, urine AA, metabolic fecal nitrogen, Gain & growth AA, body loss AA, lactation AA, and gestation AA (all in g/d).

SUMMARY

SHIELD is a ration evaluator for lactating dairy cows that is designed to be used in conjunction with another ration formulation package, such as PC Dairy, that creates a ration on a least-cost basis. However, SHIELD can also be used to identify potentially limiting, or oversupplied, nutrients in ration/animal situations that are known to have occurred or are projected to occur.

A more complete article on SHIELD is at: animalscience.ucdavis.edu/shield.htm