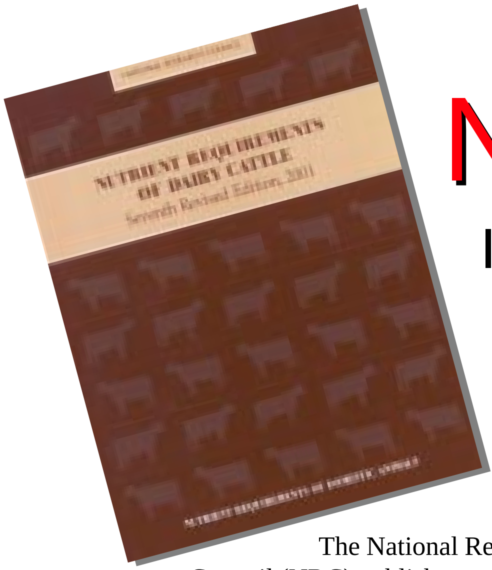

NRC Dairy 2001

Implications for Rendered Products

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The National Research Council (NRC) publishes a series of books on the nutrient requirements of domestic animals. Periodically, it convenes a panel of scientists to revise the nutrient requirements of a specific species. The committee has just completed revising the 1989 publication on the *Nutrient Requirements of Dairy Cattle*. It is the seventh revision and was released in January 2001. There are many changes from the 1989 NRC publication and this article will outline those that are important to the rendering industry.

Protein

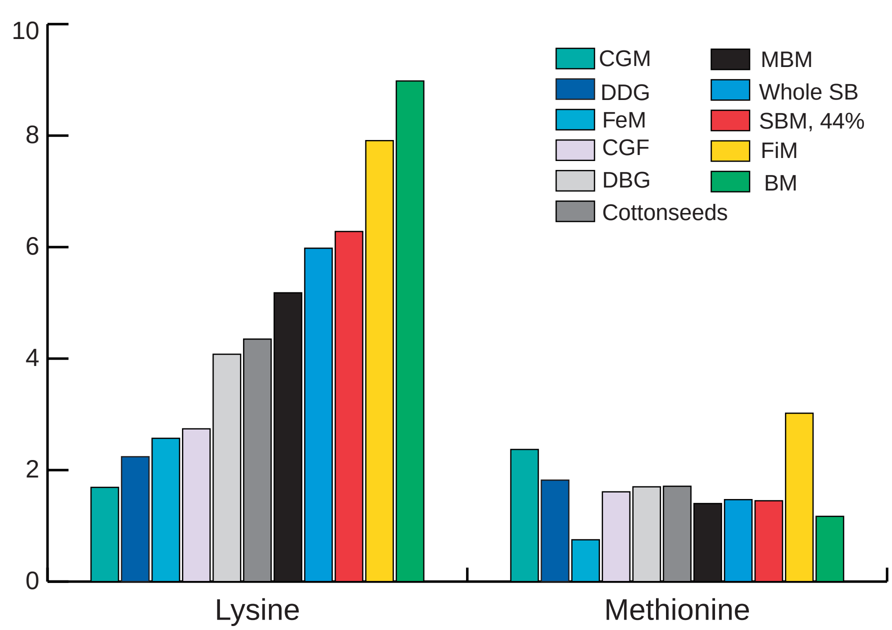
A little background in protein nutrition is necessary to appreciate the importance of animal proteins in dairy diets. Protein is required for maintenance and growth and to support lactation and pregnancy. Dietary protein that is consumed by dairy cattle is either degraded by microorganisms in the rumen (rumen degradable protein (RDP)) or escapes degradation (rumen undegradable protein (RUP)) and passes to the small intestine for digestion and absorption of the resulting amino acids. RDP is important because the nitrogen it contains is made available for microbial growth. Microbes can flow to the intestine and, along with RUP, can be important sources of amino acids for milk protein production. The NRC reference book that was published in 1989 was the first to list RUP and RDP content of feeds and the requirements of dairy cows for these protein fractions. Feeds tend to be high in RDP and very rarely are diets for dairy cattle deficient in RDP. Having sufficient RUP in diets is critical because the protein (amino acid) needs of high producing dairy cows cannot be met by microbial protein alone.

Animal products such as bone meal (BM), meat and bone meal (MBM), fish meal (FiM), and feather meal (FeM) can be important ingredients in dairy diets, particularly during times when milk production and the need for amino acids is greatest. They are rich in protein and a large proportion of the protein is RUP. Their inclusion in diets helps to ensure that the RUP:RDP ratios are not unbalanced. Many of the animal proteins are rich in lysine, methionine, or both, and consequently may be used in diets to minimize the likelihood of a deficiency in the two amino acids that are most often limiting in dairy diets.

Table 1 shows the crude protein (CP), RUP, and digestibility of RUP for animal proteins in the 1989 and 2001 NRC feed libraries. Feather meal was not part of the 1989 feed library. Crude protein values for MBM and FiM were similar between the two publications; CP for BM was increased from 87 to 95 percent.

When the last NRC book was published, RUP values were available for only a few feeds and for each of those feeds there were very few estimates. It was also assumed that RUP values were constant under all feeding conditions. Many more RUP values were available for the new NRC, and it is recognized that RUP values are not constant. If a cow eats more feed, the feed spends less time in the rumen and there is less time for microbial degradation. Therefore, the RUP value of feeds increase as feed intake increases. The computer

Figure 1. Lysine and Methionine Content of Animal and Plant Protein Sources



CGM = corn gluten meal, DDG = distillers dried grains, FeM = feather meal, CGF = corn gluten feed, DBG = dried brewers grains, MBM = meat and bone meal, Whole SB = whole soybeans, SBM = soybean meal, FiM = fish meal, BM = blood meal program associated with the 2001 NRC publication allows for the calculation of RUP at any level of feed intake. The new NRC feed library lists RUP values when the cow is eating at twice or four times the level of feed intake that is required for maintaining the cow, i.e., conditions of high or low milk production. Except for BM, RUP levels at four times maintenance are higher than RUP values listed in 1989 (Table 1). The higher RUP value means MBM has more value. Concerns about palatability typically limit the amount of animal protein that is incorporated into dairy diets. Therefore, it is unlikely that higher CP or RUP content will dictate lower inclusion rates.

In the 1989 publication, it was assumed that all RUP was 80 percent digestible in the small intestine. Recent research suggests that value is not constant. For the latest revision, variable digestion coefficients for RUP are assigned to different feeds. Blood meal retained the 80 percent RUP digestibility value that was used in the 1989 edition (Table 1). RUP digestibility of FiM was increased to 90, but that of MBM and FeM was lowered to 60 and 70 percent respectively. Recent research from the University of Illinois that was not available to the NRC committee indicates that MBM RUP, on average, has greater digestibility than 60 percent. More estimates of MBM digestibility in ruminants are needed.

Just as the last NRC was pioneering for recognizing the importance of RUP and RDP, the latest NRC is the first to include amino acid values of feeds and provide guidelines for formulating diets for two essential amino acids, lysine and methionine. While the new NRC book falls short of listing animal requirements, it provides a recommendation of "profiles" of amino acids that would need to be absorbed to maximize milk protein percentage and production. Figure 1 shows the lysine and methionine content of animal protein sources. With the exception of FeM, animal proteins are good sources of lysine and the emphasis of the new NRC publication on amino acid nutrition should help highlight the beneficial effects these products may have in dairy diets. Unfortunately, besides FiM, animal proteins are poor sources of methionine. However, with the commercialization of products containing methionine that is protected from rumen degradation, there are greater opportunities for formulating dairy diets similar to swine and poultry diets. That is, feeding a low cost protein source and supplementing diets with a specific limiting amino acid.

Table 1. CP, RUP, and RUP Digestibility of Animal Protein Sources (NRC, 2001)

	1989	2001
Meat and Bone Meal		
CP, %	54.1	54.2
RUP, %CP	49	2x: 51.4 4x: 58.2
RUP digest., %	80	60
Blood Meal, ring dried		
CP, %	87.2	95.5
RUP, %CP	82	2x: 70.9 4x: 77.5
RUP digest., %	-	80
Feather Meal, w/some vicera		
CP, %	-	85
RUP, %CP	-	2x: 62.1 4x: 65.4
RUP digest., %	-	70
Fish Meal, menhaden		
CP, %	66.7	68.5
RUP, %CP	60	2x: 59.1 4x: 77.5
RUP digest., %	80	90

The new NRC made important changes to the assigned mineral absorption coefficients of feeds. This has implications for MBM, which is rich in calcium and phosphorus. The 1989 NRC assumed an absorption coefficient of .35 for calcium and .50 for phosphorus for all feeds. For 2001, they have assigned absorption coefficients for calcium of .30, .60, and .5 to .95 for forages, concentrates, and inorganic calcium sources. For phosphorus, the corresponding coefficients are .64, .70, and .3 to .95. Meat and bone meal is considered a concentrate, so absorption coefficients have increased in the new NRC (Table 2). There is research to indicate that calcium and phosphorus availability from MBM is greater than .6 and .7. Ideally, the NRC would have assigned a unique absorption coefficient to each feed. Since there was not sufficient data to do that for all feeds, the three-way categorization was selected. Although not perfect, it represents an improvement over the one-size fits all approach taken in 1989.

Fat

The major changes in the 2001 NRC reference book are more types of fat included in the feed library and unique energy values for each source. In 1989, the same energy value was listed for three fat sources: fat, animal, hydrolyzed; fat, swine, lard; and oil, soybean. The five fat sources listed in the revised NRC publication are: calcium salts of palm fatty acids (FA); hydrolyzed tallow fatty acids; partially hydrogenated tallow; tallow; and vegetable oil. Research conducted in the 1990s clearly indicated these fat sources should not have the same energy value.

Figure 2 illustrates that energy losses in feces, gas, urine, and heat dictate the net energy (NE) value of a feed, i.e., the energy that is available for maintenance, growth, pregnancy, and lactation. The starting point, i.e., gross energy (combustible energy) value of fat, is dependent on the chemical make up of the fat source. For example, calcium salts of palm fatty acids are approximately 15 percent calcium, which contains no gross energy. Fat sources that are comprised of triglyceride have less gross energy than one that is pure fatty acids. That is because triglyceride contains glycerol which is a carbohydrate, has less gross energy than fatty acids, and "dilutes" the concentration of total gross energy. Digestibility of the fat source (i.e., energy loss in feces) is the only other important factor affecting the NE

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content. This is because there is no energy loss from fat as gas or urine and the energy loss as heat is assumed to be 20 percent of metabolizable energy for all fat sources.

In the 2001 NRC publication, energy values of fat sources reflect chemical make-up and digestibility. Gross energy content of the fat sources was determined from chemical make-up and known gross energy values for the individual components comprising the fat source. Digestibility values were determined from the literature. Mean digestibility coefficients at maintenance level of intake and the corresponding standard deviations and number of determinations are listed in Table 3 for each fat source. In the last column is the NE value listed in the new NRC book for each fat source assuming the cow is eating at three times the level of feed required for maintenance (moderate level of milk production and feed intake). Note that there were no values for digestibility of vegetable oil from the literature. Therefore, digestibility was assumed to be 80 percent at a three times maintenance level of intake (same as that assumed in the 1989 NRC publication) and 86 percent at maintenance level of intake. The assumption of high digestibility for vegetable oil is probably realistic because research does indicate that there is a positive relationship between digestibility and degree of unsaturation of a fat source.

The NE value for tallow listed in the 2001 NRC book when cows are eating at three times maintenance is 4.53 Mcal/kg. The energy value listed in the 1989 edition was 5.84 Mcal/kg. (That number was actually wrong. It should have been 6.24 Mcal/kg according the methodology described for determining the number. Apparently a calculation error was made but not caught in review.) The value for tallow is lower in the new reference book because the digestibility value *derived* from the literature was lower than that *assumed* for the previous edition. There was also a discount because tallow is a triglyceride (contains glycerol) and is not pure fatty acid. The reason for the low digestibility coefficient for tallow is unknown. It is lower than would be predicted based on examination of the fatty acid profile of tallow. Some of the digestibility values were from obtained studies in which very high levels of tallow were being fed, as much as five percent of diet dry matter. However, research on the effects of level of fat supplementation on digestibility is ambiguous and high inclusion rates probably do not explain the extremely low digestion coefficient for tallow. More research needs to be conducted to confirm or refute the digestion coefficient for tallow used in the new NRC book. If digestion is lower than 80 percent, research needs to be conducted to determine why and how it can be improved.

In addition to new energy values for fat, there are new energy values for all feeds. For the first time, energy values for feeds can be calculated from compositional data obtained from feed analysis. If feed analysis is not available, tabular values can be used as default. On average, at three times level of maintenance intake, feeds will have about two percent less NE than comparable feeds listed in the 1989 guide. Forages, especially low quality forages, have five to six percent lower NE values. High protein feeds will have higher NE values; starch-rich concentrates will have similar NE values. Net energy values for some feeds will change dramatically. Two examples are cottonseeds and soybeans, high-fat oilseeds that compete with tallow as fat supplements in dairy diets. The energy value for cottonseeds will be 13 percent lower and for soybeans, 25 percent higher.

What does this all mean for

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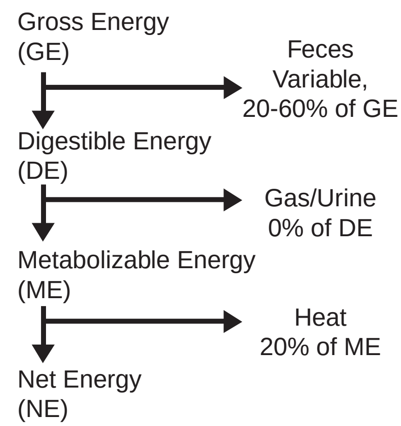
Figure 2. Energy Losses Associated with Utilization of Feeds



Gross energy is the combustible energy content of feed (e.g., fat) and represents the energy potentially available to the cow. Net energy is what is available for productive purposes (maintenance, growth, pregnancy, or lactation) after energy is lost in feces, urine, gas, and heat produced from digestion and metabolism.

Table 2. Concentration of and Absorption Coeffients (AC) of Calcium (Ca) and Phosphorus (P) in MBM (NRC, 2001)

	1989	2001
Ca, %	11.06	10.60
Ca AC,		
% of total	38	60
P, %	5.48	4.73
P AC,		
% of total	50	70

Table 3. Mean Digestibility of Fat Sources at Maintenance Level of Feed Intake and Corresponding Net Energy (NE) Values at Three Times Maintenance Level of Intake (NRC, 2001)

	Mean Digestibility (Maintenance)	Standard Deviation	No. of Observations	NE (3x Maint.)
Ca Salts of Palm FA	.86	.11	15	5.02
Tallow	.68	.13	10	4.53
Hydrol. Tallow FA	.79	.08	9	5.41
Part. Hydrog. Tallow FA	.43	.13	9	2.97
Veg. Oil	.86	-	-	5.65

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tallow utilization in dairy diets? One might expect that if feeds on average have a lower energy value, then the need for supplemental fats in diet formulation would increase. That would be the case if the new NRC reference did not change estimates of feed intake and energy requirements for cows. Estimates for energy requirements did not change substantially but estimates of feed intake were increased. A diet formulated using feed values from the revised book will be less energy dense than the same diet formulated using the 1989 publication, but because the new NRC predicts cows will eat more, energy requirements may be satisfied without the need for higher inclusion rates of supplemental fat. However, there may be circumstances in which more supplemental tallow is required, e.g., diets high in cottonseed.

The Bottom Line

Changes between the 1989 and 2001 NRC nutrition reference book for dairy cattle are numerous and some are pertinent to the rendering industry. Nutritionists working for or with rendering companies that produce products for incorporation into dairy diets should read and become familiar with the latest edition of this publication for dairy cattle. ❖