Using Neutral Detergent Fiber Digestibility in Dairy Ration Formulation

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Neutral detergent fiber digestibility (NDFD) is a valuable tool to improve accuracy of ration balancing that is underutilized by most dairymen.

Forage NDFD is digested fiber expressed as a percent of total neutral detergent fiber (NDF), and can be measured/estimated by two methods. The first is *in vitro* or *in situ* digestion, where forages are placed either in beakers with rumen fluid or in small dacron bags and inserted into a cow rumen and digested for a specific period of time (usually 48 hours, though sometimes 30 or 24 hours). The amount of NDF prior to ruminal incubation is then compared to the amount of NDF remaining after ruminal incubation and NDFD is calculated.

Another approach is to estimate NDFD based on the forage lignin content. However, lignin determination is an arduous procedure and has considerable laboratory error. The relationship between lignin and NDFD differs between forage species and is affected by forage maturity and forage growth environmental conditions. Several researchers have found a poor relationship between lignin and digestibility (Robinson, et al., 2004, Jung et al 1997).

Some laboratories have reduced incubation times for *in vitro* digestion. The rationale is that shorter incubation times better describe the NDFD potential in high producing lactating dairy cows in which feed is not retained for 48 hours. The recommendation of a 48 hour NDFD value by the National Research Council, 2001, is to facilitate calculating total digestible nutrients (TDN) of forages at maintenance intakes. As fermentation time is shortened, the error of estimating NDFD increases dramatically. The real value of NDFD is to identify forages with digestible fiber that differ significantly from average and all digestion time periods sort this about the same.

The NDFD of forage can have a large impact on energy value of the diet because changes alter the TDN content of the forage. An increase in forage TDN results in an increase in dietary energy content and potential milk yield. Oba and Allen, 1997, reported that a 1 unit rise in NDFD content results in 0.37 lb/day rise in dry matter intake. Lactating dairy cows will consume more forage of a higher energy content when forages are high in NDFD.

Hoffman and Bauman, 2003, evaluated these concepts in a trial with lactating dairy cows (Table 1). Early-mid lactating dairy cows were fed diets containing red clover augmented with normal corn silage or brown mid-rib corn silage with forage bases that differed in NDFD content (approximately 45.0, 50.0 and 55.0 % of NDF). It was observed that cows ate more dry matter and produced more milk when fed forages that had a higher NDFD. Cows exhibited a marked increase in NDF intake because as NDFD is improved, NDF is digested more quickly in the rumen allowing cows to consume more dry matter or NDF.
NDFD is an excellent ration balancing tool. Use of NDFD and ash have allowed nutritionists to go from about 60% to 90% accuracy when balancing rations.

High NDFD is needed mainly in the diets of high producing lactating dairy cows. These lactating dairy cows are often in negative energy balance and diets low in NDFD have the potential to limit feed or energy intake. Other classes of dairy cattle such as dry cows and heifers can utilize forages lower in NDFD. Similarly, other ruminants such as beef cows and ewes do not have high energy demands and, therefore, lower NDFD forages can work well in their diets.

After forage NDFD has been evaluated, the value should be compared to typical *in vitro* NDFD values (that were generated from the same incubation times) for that forage species. While NDFD is close to average on about 60% of samples analyzed, variation on the remaining 40% can be great. At the World's Forage Superbowl, for example, alfalfa fiber digestibility was recorded between 29-32% acid detergent fiber (ADF). While fiber digestibility over this narrow range of ADF averaged 50% the range was from 40-67% (Figure 1). Obviously, cows fed below average digestible alfalfa would not produce milk as expected.

It is important to remember digestible fiber declines as the forage matures (Figure 2). Missing harvest windows is now doubly hurtful because fiber both increases and becomes less digestible.

What can be done if forage NDFD is low? When the forage base of a diet fed to high producing dairy cows is low in NDFD, dietary energy is usually the primary limitation. In most situations it is not feasible to supplement more grain or fat in order to improve the energy density of an early lactation diet because the maximum amount of grain or fat may already be included in the diet. If maximum is not yet reached, some additional grain or fat can be added to improve energy status.

There are two preferred management strategies to improve a lactating cow diet in which the forage base has low NDFD. The first is to replace the low NDFD forages with forages higher in NDFD. When forage inventory cannot be changed, the amount of low NDFD fed can be decreased and replaced with byproducts that are high in NDFD. Byproducts high in NDF and NDFD such as soyhulls, beet pulp and, in some situations, citrus pulp should be considered because of their potential to replace some of the lower digestible NDF in the ration with a source that is more rapidly and completely digested.

Not all byproducts are high in NDFD. For example, byproduct feeds such as cottonseed or wheat midds do not have high NDFD potential. When low NDFD forages are replaced with high NDFD byproducts, cows should show a response in dry matter intake or milk yield in a relatively short time (5-10 days) if a true change in dietary energy status was made. Therefore, supplementation strategies should be tried and evaluated short term before making long term changes in feed supplies and inventories.