Fiber, Energy & Intake Relationships for Pregnant Dairy Heifers

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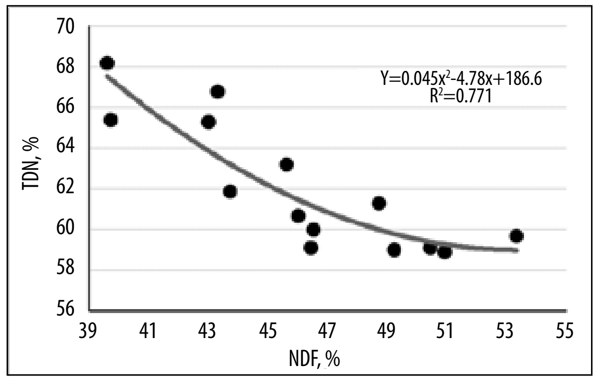
A common problem for dairy heifer farmers is the potential for excessive weight gains resulting in over-conditioning. This is especially problematic for pregnant dairy heifers having lower energy requirements than younger heifers, and may contribute to subsequent metabolic problems and depressed first-lactation milk yields. In general, there are two strategies to combat this: dilution of diets with low-energy forages or limit-feeding. Over the last decade, we have conducted five pen-based studies at the University of Wisconsin Marshfield Agricultural Research Station, mostly evaluating techniques for using diluting agents, such as straw, to reduce caloric intake by pregnant heifers. A summary of these experiments offers some clear illustrations of relationships between fiber, energy, and ad-libitum intake for heifers. Management of limit-feeding systems includes other challenges, and is not discussed here.

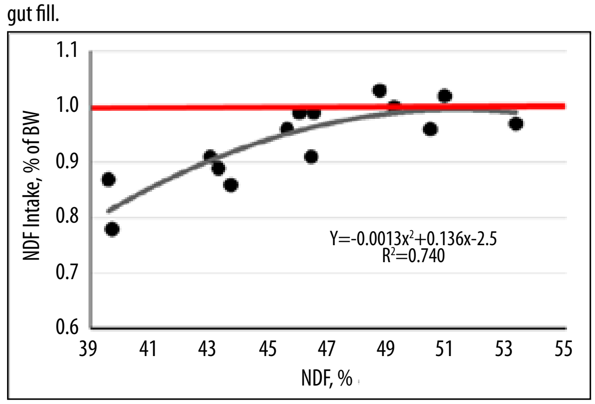
Effects of Dilution on the Energy Density of Diets. The five studies summarized in our data set contained 14 individual diets. Figure 1 shows the relationship between energy density (TDN) and the concentration of structural plant fiber (NDF) ranging ~39-53% within blended forage diets. All diets contained an alfalfa haylage/corn silage base, which either was or was not (negative control) diluted by low-quality forages. Although determination of TDN is complex, involving many inputs, it is clear that a primary driver for energy density in these diets was NDF, which explained ~77% of the variability in energy. Obviously, including diluting (high-NDF) agents, such as straw, reduces the energy density of the diet, and is one (partial) mechanism for restricting caloric intake by heifers.

Figure 1. Relationship between TDN and NDF concentration for 14 blended forage diets offered to pregnant dairy heifers.



Effects of NDF on Ad-Libitum Intake. About a decade ago, work published by the University of Wisconsin (Hoffman et al., 2008; *Journal of Dairy Science*, 91:3699-3709) included the observation that daily voluntary intake by dairy heifers was constrained by gut fill at 1.0% of bodyweight (BW) consumed as NDF. An application of this concept is shown in Figure 2 for our 14 diets described previously. For this set of diets, NDF intake ranged 0.78-1.03% of BW, but most diets with lower NDF intakes were negative control diets with little or no dilution that were too high in energy, and would lead to significant over-conditioning if offered over a period of months. For this data set, a quadratic function was best fit to the data. Based on the regression equation, the maximum NDF intake was 0.99% of BW for diets ranging 48.5-54.0% NDF. Interestingly, the NDF concentration within the diet explained 74% of the variability in NDF intake, and this relationship was improved to 87% by using metabolic BW ($BW^{0.75}$) rather than actual BW in the calculations (not shown). The aforementioned publication also described decreased intakes as heifers approached parturition that were not really evident in our data set. It should be noted, studies conducted at Marshfield generally do not include heifers that will freshen within a 6-8 week window after the conclusion of any trial. While acknowledging limits of this small data set, our studies tend to confirm the 1.0% of BW limit for NDF intake established previously.

Figure 2. Relationship between daily NDF intake (% of BW) and dietary NDF concentration for 14 blended forage diets offered to pregnant dairy heifers at Marshfield, WI. The bold red line (—) depicts the 1.0% of BW limit imposed by gut fill.



Effects of NDF on Dry Matter (DM) Intake. The 1.0% of BW limit for NDF intake by dairy heifers also provides an additional mechanism for limiting caloric intake by (pregnant) dairy heifers. Figure 3 illustrates the relationship between DM intake and dietary NDF concentration for our 14 heifer diets. It becomes quickly apparent this relationship contrasts sharply with that depicted in Figure 2. The DM intake of diets constrained by gut fill clearly declines with dietary NDF concentration. Based on the quadratic regression model for diets ranging ~39-53% NDF, DM intake is depressed by 0.25 percentage units of BW over this range. For a 1,000-lb heifer, that equates to 2.5 lbs of DM daily, clearly illustrating that dilution with low-energy forages works to restrict caloric intake by two mechanisms: reducing energy density of the diet and reducing DM intake. It should also be emphasized daily intake reduction is only beneficial when daily caloric intake is too high, and would be detrimental to proper growth and development if dilution with low-energy forages extended the dietary NDF concentration much beyond the range described in these studies.

Figure 3. Relationship between daily DM intake (% of BW) and dietary NDF concentration for 14 blended forage diets offered to pregnant dairy heifers at Marshfield, WI.