# Dairy Technical Bulletin

## How to Determine Which Dairy Herds are Likely to Respond to LFI Supplementation in their Diets.

*Stephen M. Emanuele Ph.D. PAS and Dave Lundquist PAS*

When corn and soybean meal prices are high, LFI products will least cost into dairy cattle diets but this is not always the case. Grain and protein prices always return to more normal levels in time. When this situation occurs, it is important to identify those herds which will respond to LFI supplementation. This situation is not any different than trying to determine which herds will respond to the addition of blood meal or animal fat to the diet. Adding blood meal or fat to the diet will increase ration cost but it is routinely done by nutritionists because they are trying to maximize performance. The nutritionist weighs the added purchased feed costs incurred by adding the blood meal or animal fat versus the expected response in animal performance. If the observed response in animal performance justifies the added purchased feed costs, the blood meal or animal fat remain in the diet. It is the same with the addition of LFI. Many dairy herds have LFI products in their diets regardless of corn or soybean meal price. These herds have observed an increase in animal performance with LFI in the diet that outweighs any additional purchased feed costs.

So how can we identify situations on the dairy farm where the dairy herd will respond to LFI supplementation? We must start by understanding what LFI products provide to the dairy diet. First and foremost, LFI products provide fermentable carbohydrates (sugars, soluble fiber and organic acids). The extent of digestion of the carbohydrates in LFI products is high and depending on ruminal pH will fall between 85 – 95%. Hvelplund and coworkers (2009) measured the extent of ruminal starch digestion from 19 different starch sources and reported the average extent of ruminal starch digestion to be 79% with a range of 53% to 90%. Whole oats had the lowest ruminal starch digestion and rolled barley the highest. Emanuele and coworkers (2010) reported that 12 hour ruminal starch digestion in corn processed as either ground corn or high moisture shell corn ranged from 48.5% to 73% with an average of 67%. When you bring LFI products into most diets, you will increase the amount of carbohydrate that is digested in the rumen and increase organic matter digestibility of the diet. LFI products provide the type of carbohydrates that have been shown to stimulate fiber digestibility. Molasses, sucrose, glucose and fructose have been shown to stimulate NDF digestibility when fed at less than 10% of diet DM (J. Animal Sci. 77:2793; J. Dairy Sci. 87:2997; J. Dairy Sci. 87:4221; J. Dairy Sci. 91:4801). LFI products improve the palatability and intake of forages and the first scenario where LFI supplementation would be effective is when you want to increase the intake of above average forage or intake of effective NDF in the diet. When using this strategy, the total NDF content of the diet should fall between 28% and 32% and forage NDF as a percentage of total NDF should fall between 70 – 80%. Move forage up gradually, no more than 2 units at a time (example 50% to 52%). This strategy does work as long as the total sugar in the diet is between 5.5 – 7.5% of diet DM and forage quality is good. DeVries and Gill (J. Dairy Sci. 95:2648) reported that when a molasses based liquid feed was included in the diet of Holstein dairy cows at 4.1% of diet DM, the cows ate more kilograms of ADF and NDF and produced more energy corrected milk (Table 1). Actual liquid feed intake was 2.6 kilograms as fed (1.2 kg of DM) and supplied 0.5 kilograms of supplemental sugar. This research demonstrates that the addition of liquid supplements to a wet diet (51.1% DM) reduces sorting and increases the intake of effective fiber.

**Table 1: Effect of Liquid Feed Supplementation on Fiber Intake and Milk Yield in Dairy Cows**

| Diet | Dry Matter Sugar Intake | | NDF Intake lb/d | ADF Intake lb/d | DMI, lb/d | ECM, lb/d |
|---|---|---|---|---|---|---|
| | % of Diet | lb/day | | | | |
| Control - No Liquid Feed | 51.1 | 2.49 | 17.38 | 11.44 | 60.9 | 95.0 |
| Diet with Liquid Feed | 51.9 | 3.52 | 18.04 | 11.88 | 64.0 | 102.1 |
| Significance of Difference (*P Value*) | | <0.001 | 0.06 | 0.03 | 0.019 | 0.05 |

The second scenario, where LFI products are likely to improve animal performance is when ruminal NDF or ruminal starch digestion is below average. If you observe corn grain or fiber in the manure, then chances are good that you have below average ruminal starch or NDF digestibility. If you want to confirm if this is the case, you could have a 24 hr or 30 NDFD run on forage samples and a 7 hr in vitro starch digestion run on all corn products on the farm. An alternative method would be to measure the mean particle size (MPS) of the corn grain and then use the following regression equations to estimate ruminal starch degradability.

**High Moisture Corn: Ruminal Starch Degradability (RDS) = (-0.0073) MPS + 71.9**
**Fine Ground Corn: Ruminal Starch Degradability (RDS) = (-0.0073) MPS + 76.1**

So if you have a sample of ground corn with a MPS of 1000 microns, the estimated ruminal starch degradability for the sample would be: (-0.0073) X 1000 + 76.1 = 68.8%. We would expect a response to LFI supplementation if LFI products were used to replace this ground corn because of the greater ruminal digestion of the LFI products (85 – 95%) compared to the corn.

A third scenario where LFI supplementation would be successful would be when you want to lower the starch content of the diet and feed a rumen healthy diet. High starch diets have been shown to depress dry matter intake and animal performance (J. Dairy Sci. 91:4801). When cows were fed a control diet containing 28.2% starch and 2.7% sugar, they consumed less dry matter and produced less milk than cows receiving a diet containing 24.5% starch and 7.1% sugar. A good rule of thumb is to formulate diets so that total starch + sugar is 30 – 32% of diet DM. Feeding a diet containing 24% starch and 6% sugar is healthier for the rumen than feeding a diet that is 28% starch and 2.1% sugar. How low can you go in starch? The answer depends on forage NDF digestibility. With high quality forage, you can go down to 21% starch in the diet and 7% sugar because the digestible NDF is contributing to the total amount of carbohydrate being digested in the rumen. For average quality forage, we suggest diets that contain 24 – 25% starch and 5.5% – 7.5% total sugar.

A fourth scenario where LFI supplementation will be effective is when you want to increase the dry matter intake of the transition cow. Penner and Oba (J. Dairy Sci. 92:3341) examined the impact of replacing cracked corn with sucrose during the first 4 weeks of lactation. The control diet contained 4.5% sugar and the high sugar diet contained 8.7% sugar. Sucrose supplied the supplemental sugar in the high sugar diet. Sucrose intake calculated from the reported dry matter intake of the high sugar diet and diet composition was 0.86 kilograms of supplemental sugar. Transition cows that consumed the high sugar diet ate more dry matter (+1.01 kilograms), had higher average ruminal pH (6.06 vs. 6.21), a higher maximum ruminal pH (6.65 vs. 6.83) and a higher minimum ruminal pH (5.42 vs. 5.62). All treatment effects on ruminal pH were significant at $p<0.093$. Cows that consumed the high sugar diet produced more 3.5% FCM and had a higher milk fat yield (Table 2.). Milk efficiency was similar for both treatments. What is clear from this research is that sucrose stimulated dry matter intake in fresh cows and these cows used the additional energy for milk fat synthesis and milk synthesis. Energy balance was not different among the treatments.

**Table 2. Effect of sucrose on milk and milk composition when fed to transition cows.**

| Variable | Low Sugar Diet | High Sugar Diet | *P*-Value |
|---|---|---|---|
| Dry Matter Intake, kg/d | 37.9 | 40.3 | **0.035** |
| Milk, kg/d | 72.7 | 75.8 | 0.18 |
| 3.5% FCM, kg/d | 79.6 | 84.1 | NR |
| Milk Efficiency, 3.5% FCM/lb DMI | 2.10 | 2.09 | NR |
| Milk Fat Yield, kg/d | 2.97 | 3.17 | **0.096** |
| Milk Protein Yield, lb/d | 2.31 | 2.40 | **0.23** |
| Total Net Energy Output, Mcal/d | 33.5 | 34.9 | **0.08** |

*NR = Not reported in the paper. 3.5% FCM is calculated from the reported milk yield and fat yield.*

We have identified 4 scenarios where the use of LFI liquid supplements is going to be effective. Every farm is different and the interaction between cow comfort, environment and nutrition will impact the response to LFI on a specific farm. The following table will help identify dairy herds that will respond to LFI supplementation.

| Forage Content of the Diet, % | Ruminal Starch Degradability | Mean particle size of ground corn | Forage NDF, % of Total NDF | Will respond to LFI Feeding |
|---|---|---|---|---|
| Less than 45% | Above Average | Less than 800 microns | Less than 70% | No |
| 50-60% | Above Average | 800-1000 microns | 70-80% | Yes |
| 45%-50% | Below Average | 800-1000 microns | 70-80% | Yes |
| 50-60% | Below Average to Average | 650-1000 microns | 70-80% | Yes |
| Greater than 60% | Average to Above Average | 650-1000 microns | 70-80% | Yes |

Diets with very rapid or extensive starch digestion are not a good place to use LFI unless you are using LFI to let you feed more forage, and increase forage NDF as a % of total NDF or reduce total starch in the diet.

One of the major advantages of using a LFI product in any diet is the consistency of the dry matter that the product brings to the animal. Most all of the products we as nutritionists have at our disposal to meet the nutritional needs of the lactating animal and the financial needs of the dairy producer, vary greatly in nutrient content on a daily basis. In the examples where LFI products are likely to provide a response, the intrinsic value of the liquid feed is the reduction in variation within the TMR. Lactating dairy cattle that receive consistent nutrient intake respond by improving milk efficiency, which adds to the producer's bottom line. When all is said and done, the best way to measure the value of LFI liquid supplements is to monitor the financial performance of the dairy over 12 months.