Formulation for uNDF and Rumen Fill

The rumen contains undigestible NDF (uNDF), slowly digestible NDF and potentially digestible NDF (pdNDF). The maximum NDF intake is about 18 - 22 lb (Miner data 1.27 to 1.48% BW).

For corn silage and grass haylage rations, Miner suggests that the uNDF240 hr should be about 0.3 to 0.4% of BW. This is about 5 to 6 lb of uNDF240 from TMR.

You can see in the calculations below, for a fresh cow to consume 0.3% of BW as uNDF240 to maintain good rumen fill, gut fill and control flow rate, the diet needs to be 11% uNDF (DM) for the fresh cow. To get the same uNDF intake a high cow consuming 64 lb of DMI requires less than 8% uNDF. We must be aware of intakes to transition healthy cows and allow cows to reach peak production.

<table>
<thead>
<tr>
<th></th>
<th>CUxDC</th>
<th>Fresh</th>
<th>High</th>
<th>FODC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI (example lb.)</td>
<td>26</td>
<td>42</td>
<td>64</td>
<td>30</td>
</tr>
<tr>
<td>Min (%BW)</td>
<td>0.26</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Max (%BW)</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Min (lb.)</td>
<td>4.2</td>
<td><strong>4.8</strong></td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Max (lb.)</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Min (%DM)</td>
<td>16.2</td>
<td><strong>11.4</strong></td>
<td>7.5</td>
<td>16.0</td>
</tr>
<tr>
<td>Max (%DM)</td>
<td>15.2</td>
<td>10.0</td>
<td>21.3</td>
<td></td>
</tr>
</tbody>
</table>

Larry Jones from Farme Institute suggests feeding 5 to 6 lb of uNDF 30hr from Forage. To ensure good rumen fill Larry also suggests feeding 7 lb of pdNDF (NDFd 30hr) from Forage.

Walk the cows and make sure they have good rumen fill and gut fill!
Gut fill? Rumen fill?
Chewing response is governed by physical as well as chemical attributes of forage. Important physical properties include particle size, fragility, and how quickly particles break down when chewed. Chemical properties include the moisture content which aids in swallowing, NDF content and lignification, and crosslinking which determine how long the cow must chew before swallowing the bolus.

Italian research suggests that dairy cows chew forages during eating just enough to swallow the bolus or cud. Using a combination of wet sieving and image analysis, these researchers found that the particle size of the swallowed bolus was approximately 10 to 11 mm. Although the offered forages varied from 9 to 44 mm in size, the bolus mean size was essentially the same for a range of feeds including ryegrass hay of various lengths, grass silage, corn silage, and a TMR.

Feeding long forage to dairy cows does not necessarily boost particle size in the rumen beyond the size of the swallowed bolus of feed. But, too-coarse forage can be easily sorted. Forages that are higher in NDF concentration and (or) have longer particle size also lengthen the time required to consume feed. The same Italian research group found that the chews per gram of NDF varied from 0.4 to 3.5 depending on the NDF content and particle size. Most importantly, longer particle size lengthens the time needed to consume a meal. So, depending on feedbunk management and the resulting level of competition for feed, having too great a particle size of forage may be detrimental for the cow. Forages with mean particle length greater than 10 to 11 mm take the cow longer to process – i.e., chew and swallow – and the question becomes whether or not that extra time at the feed bunk is available.

There are important time budget challenges when cows are overstocked at the feed bunk, especially for younger cows that cannot process forage fiber as effectively as mature cows. Feed bunk and pen management should provide sufficient time for the cows to eat and effectively ruminate the forage in the diet as NDF quality and particle size varies.

In the February 2017 issue of the Farm Report Kurt proposed some revised guidelines for TMR particle distributions that I’ve slightly modified and show again in Table 1. The objective of the recommendations is to feed a silage-based TMR that: 1) cows can consume within 3-5 hours/day, 2) will not require excessive ingestive chewing to form and swallow the bolus, 3) will

See CHEWING, Page 3
There are differences of opinion as to whether farmers should allow alfalfa to bloom at least once during the summer. (This discussion doesn’t include reduced-lignin alfalfa varieties.) A Michigan State University agronomist recommends that at least one harvest each season be allowed to reach 1/10th bloom. This would allow the plant to “reach a full level of carbohydrate reserves in the roots” in an effort to increase stand life. He suggested that farmers not wait until bloom “if you’re comfortable with a shorter rotation for your alfalfa fields.”

In the first place alfalfa doesn’t maximize root carbohydrates until it approaches full bloom, and there’s a fair amount of additional nutrient accumulation between 1/10th and full bloom. But more importantly, how much difference will allowing a small percentage of plants to bloom once per season make when compared to taking all harvests at the late bud stage? I think more damage is done by wheel traffic compaction than by the small gains in carbohydrates between late bud and very early bloom. Wider equipment or one fewer harvest (achievable with reduced-lignin alfalfa) would seem to have more influence on stand life than a slight delay in one summer harvest.

The Michigan State agronomist didn’t mention alfalfa-grass stands. Delaying alfalfa-grass harvest until the alfalfa reaches early bloom allows the grass to get more mature — one of the challenges with alfalfa-grass — and the reason farmers should try to choose late-maturing grasses.

I certainly don’t agree with the recommendation that the second or third cutting be the one allowed to reach early bloom. Second cut alfalfa stems (and sometimes third depending on how early second cut is harvested) lignify very quickly, and every effort should be made to get this crop harvested in the bud stage — even if it means harvesting at less than a 30-day interval. Perhaps summer conditions are different in Michigan, and to be fair the recommendations were intended for farmers in that state. That said, when managing alfalfa (and especially alfalfa-grass) for high-producing cows in the Northeastern U.S., I think farmers should time harvests so that they never see an alfalfa blossom from seeding until rotating to another crop. What sometimes happens is that wet weather, equipment breakdowns, etc. results in alfalfa coming into bloom sometime during the growing season, but that’s a lot different than intentionally letting the crop bloom.

— Ev Thomas
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**CHEWING, Continued from Page 1**

<table>
<thead>
<tr>
<th>Sieve opening, mm</th>
<th>PSPS 2013, % of as fed</th>
<th>Revised PSPS 2017, % of as fed</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>2-8</td>
<td>&lt;5</td>
<td>Sortable particles; may be too long and increase time needed for eating.</td>
</tr>
<tr>
<td>8</td>
<td>30-50</td>
<td>&gt;50</td>
<td>Functional based on physical effectiveness factor, more so than 4-mm material; maximize amount of particles retained on this sieve at 50-60%.</td>
</tr>
<tr>
<td>4</td>
<td>10-20</td>
<td>10-20</td>
<td>Functions as physical effectiveness factor sieve for calculating physically effective NDF; total of 4-, 8-, and 19-mm sieve particles is the physical effectiveness factor.</td>
</tr>
<tr>
<td>Pan</td>
<td>30-40</td>
<td>25-30</td>
<td>40 to 50% concentrate diets result in at least 25-30% of particles in the pan.</td>
</tr>
</tbody>
</table>


— Rick Grant
grant@whminer.com
Feeding through a tough forage year

Get the most out of the forages you have on your dairy farm.

by Rick Grant

For many regions of the U.S. this year, it rained much of the spring and summer. And depending on where you live, the weather eventually turned warm. We’ve known for years that wet and warm growing conditions combine to reduce forage quality by creating more lignification and undegraded NDF (uNDF).

An important question for farmers to answer will be how to most effectively feed this forage that is variable in its composition and poorly digestible. Although a relatively new tool, successful farmers will learn to make effective use of the uNDF values that have become a standard component of many farms’ forage analysis.

What is uNDF?

Indigestible NDF is highly lignified and is measured in the laboratory as uNDF240m. The uNDF240m number is obtained by fermenting a forage sample in buffer and rumen fluid using an artificial rumen system for 10 days. The final value is recalculated for any ash in the sample (so on an organic matter basis). The idea is to measure the most lignified and cross-linked NDF fraction that cannot be digested by rumen microbes.

The uNDF240m measure is more sensitive to growing conditions, plant genetics, and maturity than barley in uNDF because it is a direct measure of indigestible NDF. Indigestible NDF is sensitive to genetics, maturity, and growing conditions because it reflects variable lignification and cross-linking of lignin and phenolic acids to hemi cellulose within the forage cell wall.

Know your forage quality

The direct relationship between lignification and uNDF240m makes this measure highly useful for forage quality assessment and benchmarking. Feedback from the field on the usefulness of uNDF240m as an accurate and sensitive indicator of expected dry matter intake has been positive. Many feed companies and nutritional consultants have begun to report the uNDF240m at 20, 120, and 240 hours of fermentation. In addition, most labs report the mean (average) and range so that a farmer or nutritionist may easily benchmark their forage against a larger population and anticipate whether dry matter intake will move up or down as cows are fed various inventories of the forage.

An example of how changes in forage uNDF240m content affect dry matter intake is shown in the table from the Miner Institute dairy herd. Between October and February, forage fiber digestibility in the diet dropped and uNDF240m went up. At the same time, pen dry matter intake plummeted along with milk yield.

For our herd, it is clear that moving from 8.5 to 12 percent uNDF240m constrained intake — the rumen became filled with too much undegraded fiber. Horses that monitor uNDF240m, along with other routine measures of forage quality, will be ideally positioned to make ration changes before significant losses in feed intake and milk production occur.

Benchmarks for uNDF240m

Measured ranges in uNDF240m composition for the major forages are continuously summarized and reported by forage testing laboratories. Here is an example of the ranges that were reported by Dairy One Forage Laboratory in Ithaca, N.Y., in their May 2015 newsletter:

- Corn silage uNDF240m: 8.7 percent of DM; Range: 2.0 to 35.5 percent of DM
- Legume silage uNDF240m: 17.6 percent of DM; Range: 5.5 to 31.7 percent of DM
- Grass silage uNDF240m: 15.5 percent of DM; Range: 2.3 to 44.8 percent of DM

There is considerable variation in uNDF240m that must be measured when formulating rations and predicting cow response. Given the ranges in uNDF240m, the static relationship of lignin x 2.4 and uNDF is not sufficient. For example, even though the mean relationship between indigestible NDF and uNDF is 2.45 for legumes, the observed range is 1.3 to 4.5. For grasses it is 1 to 7.2 percent, so using a standard relationship would lead to poor estimates of forage energy value and potential dry matter intake. Assuming that a constant fraction of NDF (2.4 x lignin) is protected by lignification is untrue for legumes, grasses, and corn silages based on accumulated laboratory data.

Attention to the feedback helps

Taking advantage of the latest forage analyses, such as uNDF, allows you to formulate rations that optimize feed intake and milk production. But we cannot forget that poor feedback practices will diminish the cow’s expected response to forage quality.

In a feeding season where variable and poor quality forage will need to be fed, forcing the herd to consume these forages in a poor forage environment will make a bad situation worse. To enhance the cow’s productive response to forage, be sure to focus on these three factors.

Ensure feed accessibility. Feed availability dictates the cow’s response to diet and forage quality. When feeding forages with 24-hour, seven days-a-week access to feed produce 4 to 9 pounds per day more milk. The increased level of importance of timely feed pushup and delivery. Put simply, cows won’t respond to forage of any quality if they cannot eat it.

Fiber affects feeding behavior. Forage fiber content, particle size, and digestibility influence feeding behavior and feed intake. Our research with corn and hay crop silages shows that it is possible to change daily eating time of lactating dairy cattle by up to one hour by changing forage fiber content and digestibility.

Optimizing silage particle size is also important because excessively long particles require more chewing to swallow a bolus of feed thereby raising eating time. Under competitive feeding situations when the feedback is overcrowded, excessively coarse or lower fiber digestibility limits intake. In addition, longer forage particle size, especially the particles retained on the 19 mm screen for the Penn State Particle Separator (the top screen), are most likely to be sorted.

Starch and feeding behavior. Starch starch content and its fermentability affect rumen pectineate concentration and consequently exert substantial control over meal patterns and feed consumption. Higher producing cows respond better to higher quality forage with greater feed intake and milk production. But lower producing cows (less than 70 to 80 pounds per day of milk) will actually produce less milk when fed highly fermentable rations. So, during years when inventories of high-quality, highly digestible forages are limited, don’t overfeed them by feeding it to cows that will not respond or that may even respond negatively in milk production.

Develop your plan

High-quality forage and cow comfort have long been recognized as the foundation for a productive and healthy herd. To fully capture the nutritional value of forages, we must optimize not only nutrient composition and digestibility but also the feeding environment to encourage natural feeding behavior, dry matter intake, and milk production. Herds that focus on cow comfort and tank management this winter will get more milk from their forages than those herds that ignore their cows’ feeding environment.

Changes in feed intake and milk yield as dietary undegraded NDF changes

| Changes in feed intake and milk yield as dietary undegraded NDF changes |
|---|---|---|---|---|---|---|---|---|---|
| Pen | Date | Dry matter intake, lb./day | Milk yield, lb./day | uNDF240m Intake, % of diet dry matter | uNDF240m Intake, % of dry matter intake | uNDF240m Intake, % of body weight | uNDF240m Intake, % of DM | uNDF240m Intake, % of DM intake |
| High cows | October | 67 | 120 | 8.5 | 5.7 | 0.32 | 0.32 | 0.32 |
| | February | 62 | 105 | 12.0 | 7.5 | 0.43 | 0.43 | 0.43 |
| Low cows | October | 53 | 60 | 8.7 | 4.6 | 0.26 | 0.26 | 0.26 |
| | February | 48 | 55 | 12.1 | 5.7 | 0.32 | 0.32 | 0.32 |