More About Nutrition

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Overview

Key topics to “touch” on:
- Fermentable fiber
- Pregnancy toxemia (ketosis)
- Milk fat/protein depression
- Pasture supplementation
Plant Cell Structure

C = Cellulose
H = Hemicellulose
L = Lignin

Proteins
Sugars
Starches
Proteins

Starches
Sugars
Starches
Plant Carbohydrates

Cell Contents
- Organic Acids
- Mono+Oligo-saccharides
- Starches
- Fructans
- Pecti S. β-glucans

Cell Wall
- Hemicelluloses
- Cellulose

NDSF
NDSC
ADF
NDF
**Indigestible NDF (INDF)** = not digested in the animal and appears in feces

**Potentially fermentable NDF (pfNDF)** = Total NDF – INDF

The NDF that can be fermented and used by the animal

**Digestible NDF (NDFD)** = NDF digested – A value that can be measured in the lab. An index of pfNDF.
NFC (Nonfiber Carbohydrates)

- Sometimes called NSC (Nonstructural carbohydrates)
- Mainly starch, sugar and pectin
- Provide fermentable carbohydrate energy for the rumen bugs
- Rumen bugs synthesize microbial protein for use by the animal - high CP, high bypass, high intestinal digestibility and excellent ratio of lysine to methionine
- Cheap protein source!!
Why is This Important?

- Sheep and goats have small rumens and we need to maximize fiber digestion, rumen fermentation and microbial protein production.
- To stimulate feed intake, we need feeds that are digested in the rumen, pass from the rumen and make space for additional feed to enter.
- INDF takes up space, stays in the rumen and lowers feed intake
## NDF in Common Forages

<table>
<thead>
<tr>
<th>Item</th>
<th>NFC, % of DM</th>
<th>NDF, % of DM</th>
<th>INDF, % of DM</th>
<th>pfNDF, % of DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa hay – 1</td>
<td>27</td>
<td>42</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Alfalfa hay – 2</td>
<td>23</td>
<td>55</td>
<td>32</td>
<td>23</td>
</tr>
<tr>
<td>Orchardgrass – 1</td>
<td>20</td>
<td>47</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Orchardgrass – 2</td>
<td>13</td>
<td>67</td>
<td>31</td>
<td>36</td>
</tr>
<tr>
<td>Timothy – 1</td>
<td>20</td>
<td>55</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Timothy – 2</td>
<td>14</td>
<td>68</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>Corn silage</td>
<td>42</td>
<td>41</td>
<td>13</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: Dr. M. L. Thonney
## NDF in Common Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>NFC, %</th>
<th>NDF, %</th>
<th>INDF, % of DM</th>
<th>pfNDF, % of DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>75</td>
<td>9</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Barley – heavy</td>
<td>63</td>
<td>19</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Beet pulp</td>
<td>32</td>
<td>54</td>
<td>14</td>
<td>40</td>
</tr>
<tr>
<td>Corn gluten feed</td>
<td>18</td>
<td>45</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Distillers grain</td>
<td>10</td>
<td>50</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td>Soy hulls</td>
<td>11</td>
<td>70</td>
<td>8</td>
<td>62</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>28</td>
<td>14</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Oat hulls</td>
<td>9</td>
<td>78</td>
<td>50</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: Dr. Mike Thonney
To help in selecting the forages (type, quality) to be fed
To select the grain ingredients to provide
Can use the Feed Form spreadsheet from Dr. M. Thonney to formulate rations (www.sheep.cornell.edu)
# Late Pregnancy Ration Guidelines

<table>
<thead>
<tr>
<th>Item</th>
<th>1 lamb</th>
<th>2 lambs</th>
<th>3 lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, lbs.</td>
<td>4</td>
<td>4.2</td>
<td>4.4</td>
</tr>
<tr>
<td>CP, % of DM</td>
<td>11</td>
<td>11.5</td>
<td>12</td>
</tr>
<tr>
<td>INDF, % of DM</td>
<td>25</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>Minimum pfNDF, % of DM</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Maximum NFC, % of DM</td>
<td>32</td>
<td>34</td>
<td>36</td>
</tr>
</tbody>
</table>

Source: Dr. M. Thonney
## Early Lactation Ration Guidelines

<table>
<thead>
<tr>
<th>Item</th>
<th>1 lamb</th>
<th>2 lambs</th>
<th>3 lambs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI, lbs.</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>CP, % of DM</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>INDF, % of DM</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Minimum pfNDF, % of DM</td>
<td>22</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>Maximum NFC, % of DM</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: Dr. M. Thonney
Pregnancy Toxemia (ketosis)

- It’s actually very simple!!!
- Energy available from feed is < than the energy required by the animal for maintenance, fetal growth, mammary gland rebuilding and colostrum formation.
- Accentuated by the rapid change in demand at lambing and when milk production starts.
- May be confounded with calcium.
Net release of glucose by splanchnic tissues during the transition period and early lactation (Reynolds et al., 2003)
What Are the Driving Factors?

- Rapid fetal growth (60-70% of fetal growth in last trimester).
- Energy and protein needed to support fetal growth.
- Number of lambs the ewe is carrying
- Age of ewe (young and still growing versus mature).
- Thin ewes.
- Fat ewes.
Conceptus Weight in Sheep

Source: Dr. R. Van Saun – Penn State
If energy intake is low:
- animals try to mobilize body fat for energy
- can lower lamb birth weight
- less lamb vigor
- lower quantity and quality of colostrum

Can test for ketones in urine with test strips (purple if positive).
Based on 2007 NRC, 154 lb. ewe

Late Gestation Daily TDN Required, lbs.

1 lb. more corn grain needed

Bar chart comparing TDN requirements for single, twin, and triplet pregnancies.
Prevention

- Feed high quality and high digestible forages and feeds in late gestation and early lactation.
- Early detection of ewes that are off-feed, lethargic, droopy heads, etc.
- Make sure there is adequate access space for feed and water.
- Separate young ewes from older ewes.
- Forage testing to determine quality.
- Feed extra grain to ewes with twins or triplets.
Most common:
- Drench with 2-3 oz. propylene glycol (may need to repeat 2-3 times/day)
- IV glucose (and/or calcium)
- B vitamins?

Check with vet for other treatments.
Find highly palatable feeds and get them eating!!!! (dairy cows often like a low NDF grass hay or some calf starter with molasses).
# Milk Composition

<table>
<thead>
<tr>
<th>Item</th>
<th>Dairy Cow</th>
<th>Sheep</th>
<th>Goat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein, %</td>
<td>3.2 – 3.8</td>
<td>5.4 – 6</td>
<td>3.1 – 3.5</td>
</tr>
<tr>
<td>Fat, %</td>
<td>3.5 – 4.5</td>
<td>6 – 7</td>
<td>3.5 – 4</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.7 - 5.2</td>
<td>5.1 – 5.4</td>
<td>4 – 4.6</td>
</tr>
<tr>
<td>Energy, kcal/100 g</td>
<td>60 – 70</td>
<td>95 – 105</td>
<td>60 - 70</td>
</tr>
</tbody>
</table>
Factors affecting milk composition

- Genetics
- Stage of lactation
- Age
- Health
- Nutrition
Milk Fat Affected by Many Factors

Nutritional Factors
- fiber in the diet
- specific feeds
- feeding strategy
- ionophores

Non-nutritional Factors
- genetics
- stage of lactation
- season
- parity
- ambient temperature

Milk fat
<table>
<thead>
<tr>
<th>Milk constituent</th>
<th>Blood precursor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lactose</strong></td>
<td>Glucose</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td></td>
</tr>
<tr>
<td>Casein</td>
<td>Amino acids</td>
</tr>
<tr>
<td>Lactoglobulin</td>
<td>Immune globulins</td>
</tr>
<tr>
<td>Lactalbumin</td>
<td></td>
</tr>
<tr>
<td>Immune globulins</td>
<td></td>
</tr>
<tr>
<td><strong>Butterfat</strong></td>
<td></td>
</tr>
<tr>
<td>Fatty acids</td>
<td>Acetate, β-OH Butyrate</td>
</tr>
<tr>
<td>Glycerol</td>
<td>Long-chain FA</td>
</tr>
<tr>
<td></td>
<td>Glucose</td>
</tr>
<tr>
<td></td>
<td>Glycerol</td>
</tr>
</tbody>
</table>
Recognized by Boussingault in 1845
Naturally occurs with certain diets
Milk fat reduced but milk yield and other milk components unaffected
Milk Fat Depression Characteristics

Diet-induced

- high concentrate, low fiber
- low in effective fiber
- plant and fish oil supplements
- unsaturated fatty acids

• Specific for milk fat, up to 50% decrease

• Decreased yield of all fatty acids, but greatest for de novo synthesized fatty acids
Effect of CLA Isomers on Milk Fat

Milk Fat (percentage)

Infusion

Day

-2 -1 1 2 3 4 5 6 7 8

Control

cis-9, trans-11 CLA

trans-10, cis-12 CLA

Baumgard et al., 2000
Rumen Biohydrogenation

Linolenic Acid
\( cis-9, cis-12, cis-15 \, C_{18:3} \)

\( cis-9, \, trans-11, \, cis-15 \, C_{18:3} \)

\( trans-11, \, cis-15 \, C_{18:2} \)

\( trans-15 \, or \, cis-15 \, C_{18:1} \)

Linoleic Acid
\( cis-9, \, cis-12 \, C_{18:2} \)

\( cis-9, \, trans-11 \, C_{18:2} \)

\( trans-11 \, C_{18:1} \)

Stearic Acid \( C_{18:0} \)

\( trans-10, \, cis-12 \, CLA \)

\( trans-10, \, C_{18:1} \)

altered fermentation
y = 0.24x^2 - 6.99x

R^2 = 0.99

Percent change in milk fat yield

trans-10, cis-12 CLA dose (g/d)
Relationship Between Milk t10 C18:1 Content & Milk Fat %

\[ y = 3.3692 \times x^{-0.11783} \quad R^2 = 0.53281 \]

Overton et al., 2008 CNC
Dietary components can impact the risk of MFD in 3 ways

1. Increase C18 PUFA Precursors
   - Linoleic acid (cis-9, cis-12 18:2)
   - Rumenic acid (cis-9, trans-11 CLA)
   - Vaccenic acid (trans-11 18:1)
   - Stearic acid (18:0)

2. Alter BH pathways 'rumen environment
   - trans-10, cis-12 CLA
   - trans-10 18:1
   - Stearic acid (18:0)

3. Inhibit final step/alter rates of BH
   - Stearic acid (18:0)
How to Lower the Risk of MFD

- Don’t feed high levels of unsaturated fatty acids.
- Control levels of NFC (guideline for maximum is 32-34% in ration).
- Minimize sorting of feed.
- Adequate feed bunk space.
- Minimize “slug” feeding.
Well manage pastures are:
- high in CP (20-30% of DM)
- low in NDF and lignin
- high digestibility
- high sugar, low starch, low NFC
- medium energy

Protein is usually in excess relative to the energy the animal needs to utilize it.
Inefficient protein use, nitrogen excretion to the environment.
How Much Milk from Pasture?

(\text{CP} = 22\%, \text{NE-1} = 0.7 \text{ Mcal/lb.})
Nutrient Limitations of Pasture

- Protein: energy imbalance (high CP, low NE-l)
- High rumen degradable protein (low bypass protein)
- NFC is low
- “Effective” fiber may be low
- May see body condition loss
- May see low milk fat
- Reproduction may decrease
Expected Milk Response to Added Grain
NE SARE Project

- Bruce Clement – UNH (1999-2001)
- Used dairy sheep and goats
- Done on commercial farms
- Sheep – supplemented with 0.5, 1.5 or 2.5 lbs. of a grain mix
- Goats – supplementation rates were 1, 3 and 5 lbs. grain/day
- Done over 3 years
# Grain Mix Used (14-16% CP)

<table>
<thead>
<tr>
<th>Feed</th>
<th>Lbs./ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn meal</td>
<td>567</td>
</tr>
<tr>
<td>Soy hulls (or beet pulp)</td>
<td>380</td>
</tr>
<tr>
<td>Wheat midds</td>
<td>364</td>
</tr>
<tr>
<td>Wheat Red Dog</td>
<td>200</td>
</tr>
<tr>
<td>Distillers grain</td>
<td>150</td>
</tr>
<tr>
<td>Soybean meal (48% CP)</td>
<td>110</td>
</tr>
<tr>
<td>Molasses</td>
<td>80</td>
</tr>
<tr>
<td>Bakery byproduct</td>
<td>50</td>
</tr>
<tr>
<td>Minerals &amp; vitamins</td>
<td>99</td>
</tr>
</tbody>
</table>
No differences in daily milk production in sheep producing 2-3 lbs. of milk per day.

Pastures averaged 20% CP (up to 28%), average TDN of 60% (up to 67%)

As more grain was fed, did sheep eat less pasture?

For goats, the recommendation is to feed 1 lb. of grain for each 3 lbs. of milk produced.
Adequate nutrition and balanced rations are key components of an overall management program.

Forage and forage quality are the primary factors that determine success.

Forage testing, including NDFD, needs to be a component of your program.

With high quality forage, minimal grain supplementation is needed to maintain animal health and productivity.
With poor quality forage feeding grain will add cost and may still not optimize health and performance.

Forage allocation -
- Do you have different qualities of forage?
  - Where are they stored?
  - What is the analysis?
- Can you feed specific forages to specific animal groups?
The basic principles are relatively simple.
Implementation is the hard part.
Your observational skills are key.
2 information sources:
- www.sheep.cornell.edu
- www.sheepandgoat.com (Maryland)