Evaluating Hay Quality

Daniel Hudson
Sid Bosworth
UVM Agronomists
Forage Quality

• Measure of **Nutritional Value**
  – Protein
  – Fiber
  – Starch + Sugars + non-fiber carbohydrates
  – Energy
  – Vitamins
  – Minerals

• Measure of potential **Intake**

• Quality also reflects **Palatability**
Forage Quality

• Palatability - Relates to forage selection when there is a choice (animal behavior)

Examples:
– Thorny/bitter weeds
– Horsenettle in hay
– Acid preservative treated hay
– Alkaloids in Reed canarygrass
Forage Quality

• Anti-quality factors - Plant chemicals that cause animal disorders

Examples:
– Mycotoxins and molds
– Endophyte in tall fescue
– Poisonous plant contamination
– Red clover slobbers
– Ergot
Early harvested forage

Late harvested forage

Thin cell wall:
- low NDF (=high intake)
- low ADF (=high energy)

Thick cell wall:
- high NDF (=low intake)
- high ADF (=low energy)

cell wall

cell solubles

From: University of Missouri
Food Pyramid!

- Same concept for ruminants
- Certain dietary requirements for optimal performance
  - Vary with species
  - Physiological stage: growth, lactation, maintenance, etc
Algebra!

- Forage + Concentrate = ration
  - Do I need to supplement or not?
  - Testing is the only way to know
Practically Speaking

- Serious livestock producers should feed hay that has been tested.

- Many/most small scale producers do not test it . . . “Why would I? I sell it all anyway!”

- The only possible reasons not to test:
  - Perceived benefit
  - What I don’t know must not matter
  - Ignorance is bliss [but it can be expensive]
What should I test for?

• Crude Protein (CP)

• Acid Detergent Fiber (ADF)
  – Used to calculate total digestible nutrients (TDN)
  – Low levels indicate high digestibility

• Neutral Detergent Fiber (NDF)
  – Can be used to predict intake
  – Needed to help determine concentrate requirements to meet goals

• Other parameters should also be considered
NDF

• They can only fit so much in their rumen at one time
• NDF indicates how bulky the forage is

• Generally, they can fit about 1.2% of their body weight in their rumen as NDF
Components of NDF

• Cell wall constituents
  – Cellulose
  – Hemicellulose
  – Lignin

• Higher NDF → Lower intake
Neutral Detergent Fiber

Dry Matter Intake (% of body weight) = 120 ÷ NDF

DM Intake (% of BW)

Low

High

% NDF
ADF

- Cell wall constituents
  - Cellulose
  - Lignin

- A predictor of energy intake

- High ADF $\rightarrow$ lower intake of energy
An example follows:

For legumes:

NEL = 1.037 - 0.0124 x ADF
NEM = 1.037 - 0.0124 x ADF
NEG = \[2.54 - (2.42/(NEM \times 2.2))\]/2.2
TDN = 8 + 86 \times NEL

For alfalfa with 34% ADF:

NEL = 0.62
NEM = 0.62
NEG = 0.35
TDN = 61

From University of Missouri:
What is Your Target Quality?

• Early harvest → higher “quality,” lower yield
  – High CP, low ADF and NDF

• Later harvest → lower quality, higher yield
  – Lower CP, higher ADF and NDF

• Different classes of livestock have different requirements
## Typical Forage Quality

<table>
<thead>
<tr>
<th>Crop</th>
<th>% C.P.</th>
<th>NE&lt;sub&gt;L&lt;/sub&gt;</th>
<th>%ADF</th>
<th>%NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Silage</td>
<td>7.9</td>
<td>0.72</td>
<td>27.5</td>
<td>45.0</td>
</tr>
<tr>
<td>Legume Haylage</td>
<td>19.5</td>
<td>0.59</td>
<td>37.0</td>
<td>48.1</td>
</tr>
<tr>
<td>Legume Hay</td>
<td>19.3</td>
<td>0.62</td>
<td>34.5</td>
<td>41.3</td>
</tr>
<tr>
<td>Grass Haylage</td>
<td>14.4</td>
<td>0.52</td>
<td>37.5</td>
<td>59.1</td>
</tr>
<tr>
<td>Grass Hay</td>
<td>12.2</td>
<td>0.51</td>
<td>38.3</td>
<td>58.5</td>
</tr>
<tr>
<td>Mixed Haylage</td>
<td>17.0</td>
<td>0.56</td>
<td>37.0</td>
<td>53.8</td>
</tr>
<tr>
<td>Mixed Hay</td>
<td>14.7</td>
<td>0.56</td>
<td>37.0</td>
<td>52.7</td>
</tr>
<tr>
<td>Pasture</td>
<td>21.3</td>
<td>0.63</td>
<td>29.4</td>
<td>48.4</td>
</tr>
</tbody>
</table>

*3 year average UVM Forage Testing Lab*
Factors affecting hay quality

- Stage of plant development
- Legume, weed, ash content
- Species and variety
- Seasonal growth conditions (heat, moisture)
- Length of dry-down and exposure to sun
- Handling (excessive tedding/raking)
- Exposure to moisture
- Moisture at harvest
Staging Grasses

Vegetative

Elongating

Boot

Heading
Hay Quality Depends Which Cut and Stage at Cut
Early harvested forage

Late harvested forage

Thin cell wall:
- low NDF (=high intake)
- low ADF (=high energy)

Thick cell wall:
- high NDF (=low intake)
- high ADF (=low energy)
Table 2
Relationships between energy values for alfalfa

<table>
<thead>
<tr>
<th>Term</th>
<th>ADF (percent)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30.00</td>
<td>40.00</td>
</tr>
<tr>
<td>NEL (Mcal/lb)</td>
<td>0.66</td>
<td>0.54</td>
</tr>
<tr>
<td>NEM (Mcal/lb)</td>
<td>0.66</td>
<td>0.54</td>
</tr>
<tr>
<td>NEG (Mcal/lb)</td>
<td>0.40</td>
<td>0.23</td>
</tr>
<tr>
<td>TDN (%)</td>
<td>65</td>
<td>55</td>
</tr>
</tbody>
</table>

From: University of Missouri
Species and Forage Quality

Forage Crop Species

• Legumes verses Grasses
Species and Forage Quality
Legumes Verses Grasses

- Legumes have higher CP and lower NDF content

<table>
<thead>
<tr>
<th>Forage</th>
<th>Stage</th>
<th>CP</th>
<th>DE</th>
<th>NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>First Flower</td>
<td>18</td>
<td>2.42</td>
<td>45</td>
</tr>
<tr>
<td>Timothy</td>
<td>Boot</td>
<td>12</td>
<td>2.20</td>
<td>55</td>
</tr>
<tr>
<td>Timothy</td>
<td>Head</td>
<td>9</td>
<td>1.98</td>
<td>&gt;60</td>
</tr>
</tbody>
</table>
Species and Forage Quality
Legumes Verses Grasses

- Legumes have higher Ca content

<table>
<thead>
<tr>
<th>Forage</th>
<th>Stage</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>First Flower</td>
<td>1.75</td>
<td>0.28</td>
</tr>
<tr>
<td>Timothy</td>
<td>Boot</td>
<td>0.50</td>
<td>0.25</td>
</tr>
<tr>
<td>Timothy</td>
<td>Head</td>
<td>0.41</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Weeds can have similar forage quality to forage plants.

Their quality response to maturity is similar.

Weeds tend to mature quicker than most crops.
Pests and Forage Quality

Weeds

• Broadleaf weeds may slow down drying
Garbage in, garbage out!

- Representing TONS of hay with a teaspoon-sized sample..... protocol is important!
- Core sampling probe
- Powerful drill
# Quality test of single bales of alfalfa hay.

<table>
<thead>
<tr>
<th>Bale No.</th>
<th>DM%</th>
<th>CP%</th>
<th>ADF%</th>
<th>NDF%</th>
<th>RFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87.9</td>
<td>18.2</td>
<td>35.3</td>
<td>44.6</td>
<td>128</td>
</tr>
<tr>
<td>2</td>
<td>86.7</td>
<td>18.4</td>
<td>35.8</td>
<td>48.7</td>
<td>117</td>
</tr>
<tr>
<td>3</td>
<td>86.6</td>
<td>18.4</td>
<td>36.1</td>
<td>44.3</td>
<td>128</td>
</tr>
<tr>
<td>4</td>
<td>87.3</td>
<td>18.9</td>
<td>32.5</td>
<td>39.0</td>
<td>152</td>
</tr>
<tr>
<td>5</td>
<td>88.4</td>
<td>19.8</td>
<td>31.4</td>
<td>38.3</td>
<td>156</td>
</tr>
<tr>
<td>6</td>
<td>87.1</td>
<td>19.8</td>
<td>32.7</td>
<td>41.5</td>
<td>142</td>
</tr>
<tr>
<td>7</td>
<td>85.9</td>
<td>20.3</td>
<td>32.7</td>
<td>40.0</td>
<td>148</td>
</tr>
<tr>
<td>8</td>
<td>88.0</td>
<td>20.3</td>
<td>31.5</td>
<td>38.5</td>
<td>156</td>
</tr>
<tr>
<td>9</td>
<td>85.6</td>
<td>20.3</td>
<td>36.9</td>
<td>54.1</td>
<td>103</td>
</tr>
<tr>
<td>10</td>
<td>85.5</td>
<td>20.4</td>
<td>32.1</td>
<td>40.6</td>
<td>146</td>
</tr>
<tr>
<td>11</td>
<td>87.4</td>
<td>20.5</td>
<td>32.0</td>
<td>39.2</td>
<td>152</td>
</tr>
<tr>
<td>12</td>
<td>86.9</td>
<td>20.5</td>
<td>32.5</td>
<td>39.1</td>
<td>151</td>
</tr>
<tr>
<td>13</td>
<td>86.4</td>
<td>20.8</td>
<td>31.5</td>
<td>41.2</td>
<td>145</td>
</tr>
<tr>
<td>14</td>
<td>86.2</td>
<td>20.8</td>
<td>33.4</td>
<td>42.0</td>
<td>139</td>
</tr>
<tr>
<td>15</td>
<td>88.0</td>
<td>21.2</td>
<td>30.3</td>
<td>35.7</td>
<td>170</td>
</tr>
<tr>
<td>16</td>
<td>84.7</td>
<td>21.3</td>
<td>31.4</td>
<td>38.5</td>
<td>156</td>
</tr>
<tr>
<td>17</td>
<td>86.8</td>
<td>21.4</td>
<td>29.3</td>
<td>33.9</td>
<td>181</td>
</tr>
<tr>
<td>18</td>
<td>89.9</td>
<td>21.5</td>
<td>28.6</td>
<td>33.7</td>
<td>184</td>
</tr>
<tr>
<td>19</td>
<td>85.2</td>
<td>21.8</td>
<td>32.1</td>
<td>40.3</td>
<td>148</td>
</tr>
<tr>
<td>20</td>
<td>87.8</td>
<td>22.4</td>
<td>29.4</td>
<td>37.0</td>
<td>166</td>
</tr>
<tr>
<td>Minimum</td>
<td>84.7</td>
<td>18.2</td>
<td>28.6</td>
<td>33.7</td>
<td>103</td>
</tr>
<tr>
<td>Maximum</td>
<td>89.9</td>
<td>22.4</td>
<td>36.9</td>
<td>54.1</td>
<td>184</td>
</tr>
<tr>
<td>Average</td>
<td>86.9</td>
<td>20.4</td>
<td>32.4</td>
<td>40.5</td>
<td>148</td>
</tr>
<tr>
<td>Composite</td>
<td>88.1</td>
<td>20.7</td>
<td>31.5</td>
<td>40.7</td>
<td>147</td>
</tr>
</tbody>
</table>

Source: Dairy One, Ithaca, NY
How many, which way?

- 20 random bales from the lot
- Squares: test from the end of the bale across flakes
- Round: across the layers, not from the end
- Combine the cores
- Submit a sub-sample for testing
  - Beware of settling
What if I Won’t Test?

• Recognize visual attributes of quality hay
• Smell is also important
• “How to Judge Hay Quality Visually”
  – [http://www.agecon.ag.ohio-state.edu/programs/FarmManagement/Budgets/crops-2008/index.htm](http://www.agecon.ag.ohio-state.edu/programs/FarmManagement/Budgets/crops-2008/index.htm)
High vs Low Quality Characteristics

- Leafy (intact)
- Fine-stemmed
- Few seed heads or blossoms
- Green
- Good smell
- Few weeds
- No foreign material

- Few leaves
- Shattered leaves
- Coarse
- Stemmy
- Full of seed heads or blossoms
- Musty smell
- Bleached or brown
- Soil or foreign material
- Noxious weeds
How can you tell?

- **Buyers:** ask the seller to break a bale
  - Offer to pay for it
- **If they won’t, don’t buy it**
- **No forage quality test, no inspection**
  - Why would you buy it??

- **Producers:** educate your customers
Pay!

- Generally, you get what you pay for
- You can pay now or pay later, but you will always pay
  - Pay for quality hay, testing, etc
  - Paying for excessive “quality”
  - Pay for lost production/animal performance
Let the Buyers and Sellers Beware!

• Lots of hay scams out there
• Especially when there is a shortage and livestock owners are desperate
• There will be new scams!
Questions?

Sid Bosworth
Daniel Hudson
UVM Agronomists