Factors that Affect Forage Quality

Jose Dubeux

dubeux@ufl.edu
What is forage quality?

High-quality forage

“Forage that contains large concentrations of digestible energy and is capable of being consumed in large amounts”

Hancock et al., 2014
What is forage quality?

- Forage nutritive value
  - Forage digestibility
  - Forage chemical composition
  - Nature of digested products/
    efficiency of nutrient utilization

- Voluntary feed intake
Forage production per Acre -> Proportion consumed -> Consumption per acre (Quantity aspect)

Forage Quality:
- Forage nutritive value
- Voluntary intake
- Animal potential

Chemical composition
- Digestibility
- Nature of digested products
- Accessibility
- Acceptability
- Retention time

Age, size, and sex of animal
- Genetic potential
- Previous treatment
- Environmental effects
- Feed supplements

Unit of measure:
- Animals per acre
- Gain per animal
- Output per animal (Quality aspect)

Adapted from Mott and Moore, 1985
Factors affecting forage nutritive value
Forage species

Summer annuals (Pearl Millet, Sudangrass): 1 to 1.5 lb/d

Bahiagrass: 0.5 to 1 lb/d

Bermudagrass: 1 to 1.5 lb/d

Cool-season grasses: 1.5 to 2 lb/d

Grass/legume mixtures: 1.5 to 2.5 lb/d
Forage species

Hancock et al. (2014)
Livestock requirement and RFQ

Hancock et al. (2014)
Digestible dry matter (DDM) and crude protein (CP) of Coastal bermudagrass

Burton et al. (1963)
Animal performance and forage quality of Coastal bermudagrass hay with different maturity

<table>
<thead>
<tr>
<th>Cutting interval (weeks)</th>
<th>Dry Matter intake (lb/day)</th>
<th>Forage digestibility (%)</th>
<th>Average daily gain (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>11.8</td>
<td>55</td>
<td>1.2</td>
</tr>
<tr>
<td>8</td>
<td>9.3</td>
<td>53</td>
<td>0.9</td>
</tr>
<tr>
<td>12</td>
<td>9.5</td>
<td>45</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Source: Circular 557, University of Florida Cooperative Extension Service. Wright et al.
Forage quality and cost of supplementation using bermudagrass hay

<table>
<thead>
<tr>
<th>Maturity (weeks)</th>
<th>Crude Protein (%)</th>
<th>TDN (%)</th>
<th>Supplement required for a lactating beef cow (lb/hd/d)</th>
<th>Cost to supplement ($/hd/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>11.8</td>
<td>55</td>
<td>1.2</td>
<td>$0</td>
</tr>
<tr>
<td>6</td>
<td>9.3</td>
<td>53</td>
<td>0.9</td>
<td>$0.23-0.48</td>
</tr>
<tr>
<td>8</td>
<td>9.5</td>
<td>45</td>
<td>0.0</td>
<td>$0.53-0.75</td>
</tr>
</tbody>
</table>

Source: Circular 557, University of Florida Cooperative Extension Service. Wright et al.
Environment and management

• Soil fertility
• Rainfall regime/irrigation
• Temperature, light
• Fertilization program
N fertilization and crude protein in bermudagrass hay

<table>
<thead>
<tr>
<th>Applied N (lb/Acre)</th>
<th>Crude protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9.2</td>
</tr>
<tr>
<td>200</td>
<td>11.0</td>
</tr>
<tr>
<td>300</td>
<td>12.2</td>
</tr>
<tr>
<td>400</td>
<td>13.1</td>
</tr>
<tr>
<td>500</td>
<td>13.8</td>
</tr>
</tbody>
</table>

Source: Circular 938, University of Florida Cooperative Extension Service. Overman et al.
Development stage and chemical composition

Typical chemical composition of warm-season grasses

NDF is the major component
NDF composition and digestibility varies

Lignin

Cellulose

Hemi-cellulose

Insoluble protein/pectin

Lignin

Cellulose

Hemi-cellulose

Insoluble protein/pectin
NDF composition and digestibility of bermudagrass varieties at 3 weeks of regrowth

<table>
<thead>
<tr>
<th>Variety</th>
<th>NDF (%)</th>
<th>DM Digestibility at 48 h (%)</th>
<th>NDF digestibility at 48 h (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal</td>
<td>66.9</td>
<td>51.4</td>
<td>42.6</td>
</tr>
<tr>
<td>Tifton 85</td>
<td>68.6</td>
<td>61.7</td>
<td>60.6</td>
</tr>
</tbody>
</table>

Adapted from Mandebvu et al. (1999). J. Ani. Sci. 77:1572-1586
C3 (soybean)

mesophyll cells

C4 (corn)

bundle sheath cells
Mesophyll cells are easily digested and they are present in greater proportion in legumes and cool-season grasses (C3).

Sclerenchyma and bundle sheath cells are slowly digested and they are present in greater proportion in warm-season grasses.

Wilson and Mertens (1995)
Proteins are mostly present in thick-walled cells in warm-season grasses.
How about digestibility?

![Graph showing the relationship between time (h) and degradability (%)](Image)
Typical range of digestibility among different forages

Hancock et al. (2014)
Particle size and passage rate plays a role in digestibility

<table>
<thead>
<tr>
<th></th>
<th>Intake g DM/kg(^{0.75}).day</th>
<th>DM Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chopped</td>
<td>44.1 ± 2.0</td>
<td>51.7 ± 0.6</td>
</tr>
<tr>
<td>Pelleted</td>
<td>58.4 ± 1.9</td>
<td>45.3 ± 1.0</td>
</tr>
<tr>
<td>Difference</td>
<td>+14.3**</td>
<td>-6.4**</td>
</tr>
</tbody>
</table>

Adapted from Minson (1967)
Factors affecting voluntary feed intake
Factors affecting voluntary feed intake

- Environmental factors
- Animal factors
- Forage nutritive value
- Sward characteristics
Environmental Factors

Cattle spent from 17 to 38% of the day time (7 am – 7 pm) under the shade (Dubeux, 2005)
Animal factors

Age, weight, sex, genetic potential, physiological status, previous treatment –
All affect voluntary intake
Intake and nutritive value

Fig. 5. Relation between intake and digestibility for six varieties of Panicum (Data from Minson 1971). From MINSON, 1982.
Intake and Herbage Allowance

Fig. 3.2. The effect of forage allowance on intake by calves (○), beef (△), and dairy (□) cows. Data from Ernst et al. (1980).
Intake and Herbage Allowance

Fig. 2. Relationship of average daily gain and forage allowance (kg of forage per kg of animal live weight) for continuously stocked pearl millet [*Pennisetum glaucum* (L.) R. Br.] pastures. Adapted from McCartor and Rouquette (1977).

Sollenberger et al., 2006
Grazing management makes a difference

Undergrazing

Overgrazing
Nutritive value and herbage mass combined set the limits

Source: Duble et al. (1971) adapted by Sollenberger and Vanzant (2011)
Quality of conserved forages

• Methods of conserving forages do not improve forage quality

• There are losses in quantity and quality

• Losses occur at the field and during storage
## Losses

<table>
<thead>
<tr>
<th></th>
<th>Harvesting and Baling</th>
<th>Storage</th>
<th>Feeding</th>
<th>Total losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay, no cover/on ground</td>
<td>7-15%</td>
<td>20-40%</td>
<td>5-25%</td>
<td>30-60%</td>
</tr>
<tr>
<td>Hay, under roof</td>
<td>7-15%</td>
<td>2-10%</td>
<td>5-15%</td>
<td>15-35%</td>
</tr>
<tr>
<td>Baleage</td>
<td>3-10%</td>
<td>3-10%</td>
<td>4-10%</td>
<td>10-25%</td>
</tr>
</tbody>
</table>

Source: Hancock, 2010
# Losses

<table>
<thead>
<tr>
<th></th>
<th>Cost of production ($/ton)</th>
<th>Value of losses in the system ($/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$80</td>
<td>$100</td>
</tr>
<tr>
<td>Hay, no cover/on ground 50% losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hay, under roof 25% losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baleage 15% losses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Hancock, 2010
First things first...
Testing is essential to know what you are feeding
# Feed and Forage Analysis Report

**Client Information**
- **Georgia Farm:** 123 Bulldog Way, Prettytown, GA 3777
- **Crop:** ALFALFA
- **Use:** Hay
- **Species:** DAIRY
- **Class/Weight:** LACTATING COWS
- **Sample:** 0

**County Information**
- **County:** [Redacted]
- **Scale:** [Redacted]
- **Sample:** 43, 4
- **Date:** Jul 4, 2012
- **Fax:** 800-ASS-AKA
- **E-mail:** [Redacted]

### Near Infrared Reflectance (NIR) Analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>As-Sampled</th>
<th>Dry-Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein</td>
<td>21.5%</td>
<td>24.0%</td>
</tr>
<tr>
<td>Crude Fiber (Estimated)</td>
<td>18.7%</td>
<td>20.9%</td>
</tr>
<tr>
<td>Neutral Detergent Fiber</td>
<td>30.8%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Acid Detergent Fiber</td>
<td>23.71%</td>
<td>26.47%</td>
</tr>
<tr>
<td>Lignin</td>
<td>4.4%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Non-Rstic Carbohydrates</td>
<td>30.78%</td>
<td>34.36%</td>
</tr>
<tr>
<td>Digestible Neutral Detergent Fiber</td>
<td>16.3%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Digestible Detergent Fiber</td>
<td>47.62%</td>
<td>53.15%</td>
</tr>
<tr>
<td>Digestible Dry Matter (Estimated)</td>
<td>69.96%</td>
<td>78.09%</td>
</tr>
<tr>
<td>Moisture</td>
<td>10.4%</td>
<td>0%</td>
</tr>
<tr>
<td>Dry Matter</td>
<td>89.6%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Near Infrared Reflectance (NIR) Analysis

<table>
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<tr>
<th>Nutrient</th>
<th>As-Sampled</th>
<th>Dry-Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrates</td>
<td>840 ppm</td>
<td>938 ppm</td>
</tr>
</tbody>
</table>

### Learning for Life

The University of Georgia and Fort Valley State University, the U.S. Department of Agriculture and other sponsors of the program cooperating Cooperative Extension offers educational programs, resources and materials to all people without regard to race, color, national origin, age or disability. An equal opportunity affirmative action organization committed to a diverse work force.
Baleage is an option when weather conditions do not allow the forage to dry and make hay.
Hay

If drying conditions are adequate, hay is usually cheaper

Investing in a hay barn will pay back the $ spent
Poor quality hay lead to poor results

<table>
<thead>
<tr>
<th>Item</th>
<th>Pensacola bahiagrass hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM, %</td>
<td>92.5</td>
</tr>
<tr>
<td>OM, %DM</td>
<td>95.1</td>
</tr>
<tr>
<td>CP, %DM</td>
<td>8.9</td>
</tr>
<tr>
<td>NDF, %DM</td>
<td>84.7</td>
</tr>
<tr>
<td>ADF, %DM</td>
<td>48.0</td>
</tr>
<tr>
<td>Hay DM intake, %BW</td>
<td>2.46</td>
</tr>
<tr>
<td>Initial weight, lbs</td>
<td>515</td>
</tr>
<tr>
<td>Average Daily Gain, lbs</td>
<td>-0.33</td>
</tr>
</tbody>
</table>

Adapted from Kostenbauder et al. (2007)
If you are investing your money, do it the right way…

• Choose the right species

• Manage it right

• If conserving as hay or baleage, minimize your losses using proper management practices

• Increasing efficiency of production will improve profits
Concluding remarks

• Forage quality affects animal performance

• In a scenario of declining market, increasing ranch profitability requires greater production efficiency

• Losses in conserved forages might lead to very expensive products at the end

• Management strategies might be implemented to improve forage quality, animal performance, and ultimately, ranch profits
Thank you

dubeux@ufl.edu