Forages and Hay Quality in SW Missouri

Tim Schnakenberg
Agronomy Specialist
Galena, Missouri
417-357-6812
schnakenbergc@missouri.edu
### Springfield Precipitation Record

**Inches**

<table>
<thead>
<tr>
<th></th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>5.48</td>
<td>7.00</td>
<td>1.79</td>
<td>3.56</td>
<td>4.19</td>
<td>2.26</td>
<td>2.19</td>
</tr>
<tr>
<td>2007</td>
<td>4.04</td>
<td>4.07</td>
<td>8.11</td>
<td>2.80</td>
<td>4.34</td>
<td>4.93</td>
<td>1.88</td>
</tr>
<tr>
<td>2008</td>
<td>4.74</td>
<td>5.20</td>
<td>13.41</td>
<td>2.66</td>
<td>0.60</td>
<td>8.15</td>
<td>2.38</td>
</tr>
<tr>
<td>2009</td>
<td>8.26</td>
<td>5.52</td>
<td>4.61</td>
<td>3.70</td>
<td>4.51</td>
<td>5.63</td>
<td>9.97</td>
</tr>
<tr>
<td>2010</td>
<td>3.99</td>
<td>7.14</td>
<td>2.33</td>
<td>6.37</td>
<td>1.53</td>
<td><strong>11.65</strong></td>
<td>1.01</td>
</tr>
<tr>
<td>Average</td>
<td>5.30</td>
<td>5.79</td>
<td>6.05</td>
<td>3.82</td>
<td>3.02</td>
<td>6.52</td>
<td>3.49</td>
</tr>
</tbody>
</table>
## Probability for Successful Hay Harvesting

*(Older Springfield Data)*

<table>
<thead>
<tr>
<th>Date</th>
<th>Percent 2 Open Haying Days in Succession</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1-10</td>
<td>28</td>
</tr>
<tr>
<td>May 11-20</td>
<td>32</td>
</tr>
<tr>
<td>May 21-31</td>
<td>28</td>
</tr>
<tr>
<td>June 1-10</td>
<td>32</td>
</tr>
<tr>
<td>June 11-20</td>
<td>33</td>
</tr>
<tr>
<td>June 21-30</td>
<td>37</td>
</tr>
<tr>
<td>July 1-10</td>
<td>50</td>
</tr>
<tr>
<td>July 11-20</td>
<td>45</td>
</tr>
<tr>
<td>July 21-31</td>
<td>46</td>
</tr>
<tr>
<td>August 1-10</td>
<td>40</td>
</tr>
<tr>
<td>August 11-20</td>
<td>34</td>
</tr>
<tr>
<td>August 21-31</td>
<td>48</td>
</tr>
<tr>
<td>Sept. 1-10</td>
<td>42</td>
</tr>
<tr>
<td>Sept. 11-20</td>
<td>46</td>
</tr>
<tr>
<td>Sept. 21-28</td>
<td>36</td>
</tr>
</tbody>
</table>
Second Cutting Alfalfa-Grass Farmer Survey

<table>
<thead>
<tr>
<th></th>
<th>% CP</th>
<th>% ADF</th>
<th>% NDF</th>
<th>% TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain-Free Hay</td>
<td>16.7</td>
<td>42.2</td>
<td>52.4</td>
<td>54.4</td>
</tr>
<tr>
<td>Rained On Hay</td>
<td>13.7</td>
<td>46.2</td>
<td>62.0</td>
<td>49.8</td>
</tr>
</tbody>
</table>

Source: Ann Cowen, Iowa State Univ.
Alfalfa Digestibility

Standing 70%
1/10 Bloom 67
Rained On 57
3-Week Cutting Delay 52
A Bumper Hay Crop Doesn’t Mean A Successful Hay Crop
## Effect of Stage of Harvest on Fescue Hay Quality and Animal Gain

<table>
<thead>
<tr>
<th>Stage of Harvest</th>
<th>DM Intake lb/day</th>
<th>% Digestibility</th>
<th>% Protein</th>
<th>Lb of hay fed per lb of gain</th>
<th>Lb of hay per acre 1st cutting</th>
<th>ADG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late boot to head, cut May 3</td>
<td>13.0</td>
<td>68</td>
<td>13.8</td>
<td>10.1</td>
<td>1334</td>
<td>1.39</td>
</tr>
<tr>
<td>Early bloom stage, May 14</td>
<td>11.7</td>
<td>66</td>
<td>10.2</td>
<td>13.5</td>
<td>1838</td>
<td>0.97</td>
</tr>
<tr>
<td>Early milk stage – seed forming,</td>
<td>8.6</td>
<td>56</td>
<td>7.6</td>
<td>22.5</td>
<td>2823</td>
<td>0.42</td>
</tr>
<tr>
<td>May 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Mont Montgomery
Univ. of TN
500 lb Holstein Heifers
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
- Balage
- April Harvest
- Late Grazing
- Warm Season Forages
April Harvest

- Lower yielding, higher quality 1\textsuperscript{st} Cutting
- Improved 2\textsuperscript{nd} Cutting
- If too early, seedheads may still come
Late Grazing of Hay Fields

- March-Early April
- Late Cutting (June/July)
- Keeps in vegetative state into a drier season
Hay Production Alternatives

- Native Warm Season Grasses
  - Switchgrass
  - Big Bluestem

- Introduced Species
  - Bermudagrass
  - Red River Crabgrass
  - Caucasian Bluestem
Quality Management

Three Factors
1. Stage of Growth
2. Plant Species
3. Conditions at Harvest
• Tall Fescue / Native WSG - boot
• Orchardgrass - blooms emerged
• Bermudagrass – every 28 days
• Caucasian Bluestem – late boot
• Red Clover - 1/4 to 1/2 bloom
• Alfalfa - 1/10 bloom
• Lespedeza – 30% bloom
• Cereal Crops – boot to milk

Trash In => Trash Out
Safe Baling Moisture Recommendations

Small square
Round
Mid-size & large square

18% Moisture

20% Moisture

16% Moisture
Moist Hay

Heating

Temperature °F

70  110  150  190  230  270  310

Plant Respiration
Fungi and Bacteria
Heat Resistant Actinomycetes

FIRE DANGER

Safe Baling Moistures
Small square bales: 20%
Round bales: 18%
Large square bales: 16%
Preservatves

Organic acids
  Propionic acid
Buffered acids
  Ammonium propionate
  pH 6.0, not corrosive
  Less volatile
Ammonia, Urea

*Propionic acid-based hay preservatives have been defined by the EPA as pesticides
Ammoniating Low Quality Forage

- Apply 2.5-3% ammonia (D.M. basis).
- Excess ammonia is toxic to cattle!
- Improves dry matter intake more than forage quality.
- Typically doubles the protein in a low quality forage.
Fescue and the Endophyte

- Toxicity of Ergovaline and Total Ergot Alkaloids
- Found in seedheads and stems
The graph shows the decrease in Ergovaline (ppb) over time in days after clipping. Key points marked include 1 week, 1 month, and 1 year. The data points suggest a declining trend in Ergovaline concentration with increasing days after clipping.
Ergot Alkaloid Concentration (ug/kg)

- Green chop
- Ensiled
- Hay
- Ammoniated hay

(Roberts et al, 2002)
Ergovaline (ppb)

Fresh | Silage | Hay | NH$_3$ Hay

2004

(Roberts et al., in prep)
2005

Roberts et al., in prep

Ergovaline (ppb)

Fresh

Silage

Hay

NH\textsubscript{3} Hay

(Roberts et al., in prep)
Fescue and the Endophyte

Conclusions from MU Studies

- Hay – 1/3 disappears in the first 2 weeks; ½ disappears after 6 months of storage
- Silage – Variable results – Moisture levels can alter the results
  - High Moisture (60%) – EV disappears; TEA increases
  - Low Moisture (43%) – Less abrupt changes
Time of Day for Cutting

TNC = Total Nonstructural Carbohydrates

Burns, et al. 2007 Crop Science, 47:2190-2197
Time of Day for Cutting

TNC = Total Nonstructural Carbohydrates

Fall Harvesting
Bermudagrass Comparison – Christian County

- Less production
- Success depends on moisture
- Few or no Seedheads
- Fall “drydown phenomena”
- Allow for rest periods for warm season crops

<table>
<thead>
<tr>
<th></th>
<th>2nd Cutting (July)</th>
<th>4th Cutting (Nov)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Protein</td>
<td>12.6</td>
<td>10.4</td>
</tr>
<tr>
<td>ADF</td>
<td>35.2</td>
<td>32.0</td>
</tr>
<tr>
<td>NDF</td>
<td>65.1</td>
<td>57.2</td>
</tr>
<tr>
<td>TDN</td>
<td>58.9</td>
<td>61.5</td>
</tr>
<tr>
<td>RFV</td>
<td>88</td>
<td>104</td>
</tr>
</tbody>
</table>
Physical Traits

- Species
- Number of Seed Heads
- Leafiness
- Weed Content
- Color
- Mold
- Smell
- Feel
Testing Hay

- No grab samples
- Use core sampler with electric drill or brace
- Small and Large Square Bales
  - >10 bales from the end
- Large Round Bales
  - 5-10 bales from side of roll
- Place 1 qt in plastic bag
- Send to a lab certified by the National Hay Testing Assn.
Forage Quality

Working definition
“high protein, low fiber”

Measured Components
Acid Detergent Fiber (ADF)
   = cellulose & lignin
Neutral Deterg. Fiber (NDF)
   = total cell walls
   = cellulose, lignin & hemicellulose
Nitrogen
Minerals
Antiquality

Calculated Components
Net Energy (NE)
   calculated from ADF
Total Digestible Nutrients (TDN)
   calculated from ADF
Digestible Dry Matter (DDM)
   calculated from ADF
Dry Matter Intake (DMI)
   calculated from NDF
Relative Feed Value (RFV)
   calculated from NDF & ADF
Relative Forage Quality (RFQ)
Crude Protein (CP)
   calculated from Nitrogen
## Hay Test Examples

<table>
<thead>
<tr>
<th></th>
<th>Fescue</th>
<th>Imported</th>
<th>Hay</th>
<th>Hay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aftermath</td>
<td>Dallis Grass</td>
<td>Show Orchgss</td>
<td>Show Alfalfa</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>8.9</td>
<td>5.5</td>
<td>17.1</td>
<td>19.9</td>
</tr>
<tr>
<td>ADF (Acid Detergent Fiber)</td>
<td>46.4</td>
<td>47.0</td>
<td>33.2</td>
<td>30.0</td>
</tr>
<tr>
<td>NDF (Neutral Det. Fiber)</td>
<td>71.8</td>
<td>72.8</td>
<td>55.6</td>
<td>35.1</td>
</tr>
<tr>
<td>TDN (Total Digestible Nut)</td>
<td>49.3</td>
<td>49.0</td>
<td>62.0</td>
<td>63.2</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0</td>
<td>0.88</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RFV (Relative Feed Value)</td>
<td>69</td>
<td>67</td>
<td>105</td>
<td>174</td>
</tr>
</tbody>
</table>
Cool Season Grasses

Forage Growth Rate

- Tall Fescue
- Perennial Ryegrass
- Orchardgrass

Month:
- Feb
- Apr
- Jun
- Aug
- Oct
- Dec
Fescue

- Majority of the hay produced
- Durable; Reliable
-Excellent quality when harvested on time
- Novel fescues are excellent choices
Orchardgrass

- Early spring producer
- Quick, high quality regrowth
- Little fall growth
- Susceptible to drought and disease
- Relatively short life span
Bromegrass

- High quality forage
- Resistant to drought
- Slow regrowth after haying
- Doesn’t tolerate abuse
- Difficult to establish
Perennial Ryegrass

- Short-lived perennial
- Excellent quality, early spring growth
- Suffers from heat, cold & drought
Winter Annuals

Wheat
Triticale
Cereal Rye
Annual Ryegrass
Oats

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>9.8</td>
</tr>
<tr>
<td>ADF</td>
<td>32.8</td>
</tr>
<tr>
<td>NDF</td>
<td>56.8</td>
</tr>
<tr>
<td>TDN</td>
<td>60.9</td>
</tr>
<tr>
<td>RFV</td>
<td>104</td>
</tr>
</tbody>
</table>
Cool Season Grass and Alfalfa
Alfalfa or Alfalfa/Grass

• One of the best protein sources for livestock
• Needs high fertility and management
• Best for hay
• Roundup Ready is back on the market
## Effect of Alfalfa Hay Quality on Beef Steer Performance

<table>
<thead>
<tr>
<th>Alfalfa Hay Quality</th>
<th>% Protein</th>
<th>% Fiber</th>
<th>DM Intake lb/day</th>
<th>ADG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>18.7</td>
<td>29.4</td>
<td>17.1</td>
<td>1.85</td>
</tr>
<tr>
<td>Fair</td>
<td>15.9</td>
<td>35.4</td>
<td>16.5</td>
<td>1.49</td>
</tr>
<tr>
<td>Poor</td>
<td>13.7</td>
<td>46.7</td>
<td>13.8</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

Source: Univ. of TN
550 lb Beef Steers
Cool Season Grass
and Legumes

Forage Yield

Cool season grass
Red Clover
White Clover
Lespedeza
Red Clover

- Short-lived perennial (biennial behavior)
- Best clover for hay
- Improves 2nd cutting quality
- Must be allowed to go to seed or overseed periodically
- Mixes well with most cool season grasses
- Needs high fertility (P > 20 lbs/acre)
White (Ladino) Clover

- Stolons allow it to persist
- Improved varieties have been released
- Excellent early growth
- Lower growing than red clover
Annual Lespedeza

- Tolerates low pH & drought
- Most growth after late June
- Striate varieties (Kobe, Legend) will mature later than Korean varieties
- Watch for shattering
- Must reseed itself
- Mixes well with cool season grasses
- Less N fixation than clovers
Warm Season Grasses

Forage Yield

- Cool season grass
- Bermudagrass
- Caucasian bluestem
- Crabgrass

Month:
- Feb
- Apr
- Jun
- Aug
- Oct
- Dec
Bermudagrass

- Warm-season grass
- Rhizomes & stolons
- Establish by sprigs or seed
- Very productive
- Requires significant fertility inputs
- Responds to litter
# Forage Yield

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>1996</th>
<th>1997</th>
<th>1998</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozark</td>
<td>6,707</td>
<td>11,189</td>
<td>11,704</td>
<td>9,867</td>
</tr>
<tr>
<td>Midland 99</td>
<td>5,980</td>
<td>11,005</td>
<td>11,119</td>
<td>9,368</td>
</tr>
<tr>
<td>Tifton 44</td>
<td>5,615</td>
<td>10,219</td>
<td>9,931</td>
<td>8,588</td>
</tr>
<tr>
<td>Hardie</td>
<td>4,580</td>
<td>7,622</td>
<td>8,366</td>
<td>6,856</td>
</tr>
<tr>
<td>Guymon</td>
<td>4,116</td>
<td>7,233</td>
<td>7,048</td>
<td>6,132</td>
</tr>
</tbody>
</table>

LSD (0.05) 1,244 1,059 1,532 992

*SW Center Test Plots – Mt. Vernon, MO*
Cutting Frequency of Bermuda

SW Center 3 Year Study – Mt. Vernon, MO – 4 Varieties
<table>
<thead>
<tr>
<th>Variety</th>
<th>Cutting Frequency 21-day</th>
<th>Cutting Frequency 28-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guymon</td>
<td>4,851</td>
<td>6,099</td>
</tr>
<tr>
<td>Hardie</td>
<td>5,546</td>
<td>6,697</td>
</tr>
<tr>
<td>Tifton 44</td>
<td>6,696</td>
<td>8,640</td>
</tr>
<tr>
<td>Midland 99</td>
<td>7,287</td>
<td>9,442</td>
</tr>
</tbody>
</table>

SW Center 3 Year Study – Mt. Vernon, MO
Caucasian Bluestem

- Quick establishment
- Grows on poor soils but responds well to fertility
- Some consider it an invasive species
Crabgrass

- High quality summer annual
- July / August cuttings
- 2 improved varieties available:
  - Red River
  - Quick-N-Big
- Must reseed annually
Native Warm Season Grasses

Yield Distribution: growing season

Yield (tons/A)

Cool-season Grass
Eastern Gamagrass
Switchgrass

Spring
Summer
Fall
Big Bluestem
Switchgrass
Eastern Gamagrass

“Prairie Hay”

- Sometimes a poor reputation
- Doesn’t test as well but performs
- Drought tolerant
- Harder to establish than introduced species
- Must be managed!!!
### Nutrient Removal Rates
(lbs removed per crop per acre)

<table>
<thead>
<tr>
<th>Type of Hay</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. Warm Season Hay (3 Ton)</td>
<td>60</td>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>Fescue Hay (3 Ton)</td>
<td>90</td>
<td>27</td>
<td>102</td>
</tr>
<tr>
<td>Fescue/Clover Hay (3 Ton)</td>
<td>150</td>
<td>25</td>
<td>114</td>
</tr>
<tr>
<td>Bermuda Hay (5 Ton)</td>
<td>250</td>
<td>45</td>
<td>170</td>
</tr>
<tr>
<td>Alfalfa/Grass Hay (5 Ton)</td>
<td>260</td>
<td>50</td>
<td>225</td>
</tr>
</tbody>
</table>

Hay can remove 80% of nutrients added to the field.
Summer Annuals

- Sorghum Sudan
- Pearl Millet
- Teff
Teff

- Alternative high quality forage
- Lower yielding than other WSG annuals
- Some grazing concerns
Sudangrass and Pearl Millet

Maximum growth from June through August

Forage yields of 5 to 7 tons/acre possible

Drought tolerant

Nice transitional crops or emergency pastures
Grazing and/or Clipping Height Critical

<table>
<thead>
<tr>
<th>Stubble height inches</th>
<th>Yield tons per acre</th>
<th>Leaf</th>
<th>Stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.4</td>
<td>4.3</td>
<td>1.2</td>
</tr>
<tr>
<td>6</td>
<td>6.0</td>
<td>4.8</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>6.7</td>
<td>6.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Nitrate Poisoning

Accumulates in lower stalks during dry weather

Avoid high rates of nitrates

Does not dissipate after hay cutting

Present mainly in sorghums, millets and Johnsongrass
Prussic Acid Poisoning

Caused by cyanide in immature or frost damaged leaves

More concentrated at heights of 24” or smaller

Dissipates during the hay curing process

Present only in sorghums - No problem for pearl millet