Forage Selection and Quality

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Outline

1. What can I grow?
   - Forage selection
2. What makes a high quality hay?
   - Forage quality
What Can I Grow?
Endophyte Infected Tall Fescue

- Fungus found in stem, leaf sheaths & seed
- Produces alkaloids toxic to livestock
- Increases progressively season long
- Minimized in young growth

Roberts and Andrae, 2004
Fescue and the Endophyte

- Toxicity from Ergovaline and Total Ergot Alkaloids
  - Other alkaloids help with disease, insect, and drought tolerance
- Found in seedheads and stems
Ergovaline Content of Hay

Days After Clipping

Ergovaline (ppb)

1 week 1 month 1 year
Ergot Alkaloid Concentration (ug/kg)

- Green chop
- Ensiled
- Hay
- Ammoniated hay

(Roberts et al, 2002)
(Roberts et al., in prep)
(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%) – ergovaline disappears; total ergot alkaloids increases
  - Low Moisture (43%) – Less abrupt changes
Consider Non-Toxic Fescue

<table>
<thead>
<tr>
<th>Location</th>
<th>AR4</th>
<th>E-</th>
<th>E+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fayetteville, AR</td>
<td>1.43</td>
<td>1.55</td>
<td>0.93</td>
</tr>
<tr>
<td>Mt. Vernon, MO</td>
<td>1.21</td>
<td>1.21</td>
<td>0.55</td>
</tr>
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</table>

West et al., 1998

Roberts and Andrae, 2004
Non-Toxic Endophyte-Infected Fescue

- Non-toxic endophytes (Novel or Friendly)
  - Retain persistent qualities
  - Animal performance similar to E-
- Available Varieties:
  - Jesup Tall Fescue with MaxQ
  - Advance with AR37
  - Bar–Optima with E34
  - Texoma with MaxQII
  - Estancia with ArkShield
  - Duramax with Armor
  - Others
Tall Fescue

- Early spring production
- Medium to high yield potential
- Excellent Persistence
- Good Tolerance to:
  - Poor Drainage
  - Low Soil Fertility
  - Drought
  - Heat Stress
  - Cold Temperatures
- Poor forage quality due to the endophyte
Problems with Toxic Endophyte Infected Tall Fescue

- Lower conception rates
- Reduced milk production
- Reduced feed intake
- Rough hair coat
- Increased core body temperature in summer (leads to heat stress)
- Frozen nose, ears, tails, etc (in winter)
- Fescue foot
Novel Endophyte–Infected Fescue

- Novel endophytes ("Friendly") retains the good qualities of fescue
- Available Varieties:
  - MaxQ
  - Advance
  - Bar–Optima
  - Others

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West et al., 1998
Feedlot performance (lbs per animal) of beef cattle after grazing three types of tall fescue.

Cattle that previously grazed E- and E++ tall fescue entered the feedlot 117 pounds heavier finished 108 pounds heavier than cattle that grazed E+ tall fescue.
Orchardgrass

- Medium to high yield potential
- Medium persistence (3 years)
- Tolerant of cold temperatures
- Fair tolerance to:
  - Poor drainage
  - Low soil fertility
  - Drought
  - Heat stress
- Forage quality can be good but matures early
Smooth Bromegrass

- Medium yield potential
- Good persistence
- Good tolerance to:
  - Cold temperatures
  - Drought
- Fair tolerance to:
  - Poor drainage
  - Low soil fertility
  - Heat stress
- Forage quality good if managed
Matua

- An improved brome
- Grows earlier & later than brome
- Excellent quality
- Stays palatable in hot summer
- Needs intensive management or will not persist!
Kentucky Bluegrass

- Low yield potential
- Good persistence
- Good tolerance to:
  - Poor drainage
  - Low soil fertility
  - Cold temperatures
- Poor tolerance to:
  - Drought
  - Heat Stress
- Forage quality good if managed
Perennial Ryegrass

- Medium to high yield potential
- Fair to poor persistence
- Fair tolerance to:
- Poor tolerance to:
- Forage quality good to excellent if managed
Timothy

- Medium yield potential
- Fair persistence
- Good tolerance to:
  - Poor drainage
  - Low soil fertility
  - Cold temperatures
- Poor tolerance to:
  - Drought
  - Heat stress
- Forage quality good if managed
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
Benefits to Including Legumes

- Improved forage quality
- Fewer problems with fescue toxicosis
- Improves animal gain
- Minimizes the need for Nitrogen fertilizer
- Longer grazing season
Steer Gains (ADG) on Fescue With and Without Clover in the Stand

Multi-Year Tests on Four Research Farms in TN and GA
Overseeding Legumes

- Conduct soil samples
  - Legumes require higher fertility

- Use inoculants

- February seeding dates have a 50% better chance than April seeding dates
Red Clover

- Medium to high yield potential
- Fair to good persistence
- Good tolerance to:
  - Cold temperatures
- Fair tolerance to:
  - Poor drainage
  - Low soil fertility
  - Drought
  - Heat stress
- Forage quality good to excellent if managed
White (Ladino) Clover

- Low to medium yield potential
- Good persistence
- Good tolerance to:
  - Cold temperatures
  - Poor drainage
- Fair tolerance to:
  - Low soil fertility
- Poor tolerance to:
  - Drought
  - Heat stress
- Forage quality good to excellent if managed
Annual Lespedeza

- Medium to low yield potential
- Good persistence if reseeding is managed properly
- Good tolerance to:
  - Poor drainage
  - Low soil fertility
  - Heat stress
  - Drought
- Forage quality good to excellent if managed
**Alfalfa**

- High yield potential
- Good persistence
- Good tolerance to:
  - Heat stress
  - Drought
  - Cold temperatures
- Poor tolerance to:
  - Poor drainage
  - Low soil fertility
- Forage quality good to excellent if managed
Perennial Warm-Season Grasses

Forage Yield

Feb Apr Jun Aug Oct Dec

Cool season grass

Bermudagrass

Caucasian bluestem
Bermudagrass

- High yield potential
- Fair to good persistence depending on cultivar
- Good tolerance to heat stress
- Fair tolerance to:
  - Drought
  - Poor soil fertility
  - Poor drainage
  - Cold temperatures
- Forage quality good if managed
Caucasian (Old World) Bluestem

- Medium yield potential
- Good persistence
- Good tolerance to:
  - Heat stress
  - Drought
  - Poor soil fertility
  - Cold temperatures
- Poor tolerance to:
  - Poor Drainage
- Forage quality good if managed
Annual Warm–Season Grasses

Forage Yield

Feb Apr Jun Aug Oct Dec

Cool Season Grass

Pearl Millet

Sudangrass

Teff

Crabgrass
Teff

- High quality forage
- Lower yielding than other WSG annuals
- Some grazing concerns
Crabgrass

- Medium yield potential
- Good persistence if reseeding is managed properly
- Good tolerance to:
  - Heat stress
  - Poor drainage
  - Poor soil fertility
- Fair tolerance to:
  - Drought
- Forage quality good if managed
Switchgrass

- Medium to high yield potential
- Good persistence
- Graze no shorter than 6”
- Graze 2–3 weeks earlier than Big Bluestem
  - Often ready for grazing before the cool season grasses have stopped producing.
- Adapts well to wetter sites
- Aggressive – Competitive
- Forage quality good if grazed early

Varieties: Cave-In-Rock; Kanlow; Alamo; Blackwell
Big Bluestem

- Medium to high yield potential
- Good persistence
- Slow to establish
  - More difficult to establish than switchgrass
- Graze no shorter than 6”
- Drought tolerant
- Forage quality good if managed

Varieties: Bonanza; Goldmine; Rountree; Kaw; Oz 70
Indiangrass

- Medium to high yield potential
- A late producer
  - 1–2 weeks later than Big Bluestem
- Good persistence
- Slow to establish
- Graze no shorter than 6”
- Good tolerance to:
  - Drought
  - Poor soil fertility
- Fair tolerance to:
  - Poor drainage
- Forage quality good if managed

Varieties: Rumsey; Cheyenne
Eastern Gamagrass

- High yield potential
  - Approximately 2 inches per day
  - 6.5 tons per acre measured in Missouri
- Good persistence
- Very slow to establish
- Graze no shorter than 6"
- Good tolerance to:
  - Drought
  - Poor drainage
- Fair tolerance to:
  - Low soil fertility
- One of the most palatable native warm-season grasses
  - SW Center dairy heifer gain data:
    - Gama = 2.1 lb/day
    - Alfagraze = 2.3 lb/day
## Milk Production from Bermudagrass vs. CSG Pasture in Summer

<table>
<thead>
<tr>
<th>Forage Type</th>
<th>Milk Yield (lb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermudagrass</td>
<td>47.0</td>
</tr>
<tr>
<td>CSG Mix</td>
<td>41.3</td>
</tr>
</tbody>
</table>
How Do I Grow High Quality Hay?
50% May Never Make It Through a Cow
Hay Quality Factors

- Forage Species
- Curing and Handling Conditions
- Stage of Maturity
Yield, crude protein (CP), and total digestible nutrients (TDN) contents of various hay crops.

<table>
<thead>
<tr>
<th>Forage Species</th>
<th>Yield (ton/Acre)</th>
<th>CP (%)</th>
<th>TDN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>3-6</td>
<td>17-22</td>
<td>57-62</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>2-5</td>
<td>12-15</td>
<td>55-60</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>2-4</td>
<td>10-15</td>
<td>55-60</td>
</tr>
<tr>
<td>Rye</td>
<td>1-4</td>
<td>8-10</td>
<td>50-55</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>1-4</td>
<td>10-16</td>
<td>56-62</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>5-8</td>
<td>10-14</td>
<td>52-58</td>
</tr>
<tr>
<td>Johnsongrass</td>
<td>2-5</td>
<td>10-14</td>
<td>50-60</td>
</tr>
<tr>
<td>Pearl Millet</td>
<td>2-6</td>
<td>8-12</td>
<td>50-58</td>
</tr>
</tbody>
</table>

Values are expressed on a dry matter basis.

Adapted from: D.M. Ball et. al. 2008. Southern Forages
Curing and Handling Conditions

- Poor weather and handling conditions can lower hay quality
  - Rain can cause leaf loss and nutrient leaching from plants
  - Sunlight can reduce Vitamin A by bleaching
  - Raking dry, brittle hay can cause excessive leaf loss
Missouri’s Hay Dilemma
## 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>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>11.65</td>
<td>1.01</td>
</tr>
<tr>
<td>2011</td>
<td>7.89</td>
<td>5.92</td>
<td>0.82</td>
<td>1.71</td>
<td>2.88</td>
<td>4.05</td>
<td>1.28</td>
</tr>
<tr>
<td>Average</td>
<td>5.78</td>
<td>5.57</td>
<td>5.86</td>
<td>3.45</td>
<td>2.77</td>
<td>6.88</td>
<td>3.39</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.
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
Curing and Handling Conditions

- The timing of when rainfall occurs after cutting will influence quality
  1. Immediately after cutting
     - Plant cells are still turgid so little moisture enters the cells and leaches the water-soluble cell contents
     - Some loss does occur, but is minimal
  2. After the hay has dried a while
     - Plant cells will re-absorb moisture and greater leaching of cell contents will occur
     - Drying will make plants somewhat brittle -- if hard pounding rains occur, leaves can be broken off, which will also lead to dry matter losses and lower quality
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
- Baleage
Baleage
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
- Baleage
- April Harvest
April Harvest

- Lower yield
- Higher quality 1st and 2nd cutting
- If too early, seedheads may still emerge
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
- Baleage
- April Harvest
- Late Grazing
Late Grazing of Hay Fields

- March–Early April
- Late Cutting (June/July)
- Keeps in vegetative state into a drier season
Strategies for Missouri’s Hay Dilemma

- Keep doing what we’ve always done
- Baleage
- April Harvest
- Late Grazing
- Warm Season Forages
### Springfield Precipitation Records

<table>
<thead>
<tr>
<th></th>
<th>Apr</th>
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<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Yr. Ave.</td>
<td>4.31</td>
<td>4.57</td>
<td>5.02</td>
<td>3.56</td>
<td>3.37</td>
<td>4.83</td>
<td>3.47</td>
</tr>
<tr>
<td>10 Yr. Ave.</td>
<td>4.29</td>
<td>5.25</td>
<td>4.93</td>
<td>3.71</td>
<td>3.64</td>
<td>4.34</td>
<td>3.68</td>
</tr>
<tr>
<td>5 Yr. Ave.</td>
<td>5.3</td>
<td>5.79</td>
<td>6.05</td>
<td>3.82</td>
<td>3.03</td>
<td>6.52</td>
<td>3.49</td>
</tr>
</tbody>
</table>
Hay Production Alternatives

• Native Warm Season Grasses
  – Switchgrass
  – Big Bluestem

• Introduced Species
  – Bermudagrass
  – Crabgrass
  – Caucasian Bluestem

Native Warm Season Grass
Hay should be baled at moistures ranging between 15 to 20%.

Bales packaged at greater than 20 percent moisture levels are at greater risk for mold, which leads to animal refusal and increased dry matter losses.
Curing and Handling Conditions

- Crushing stems (conditioning) at the time of mowing will decrease the drying time of large-stemmed plants (by approximately 1 day) and results in less leaf and nutrient loss.
- Raking hay while it is moist, 40% moisture, and baling before hay is crisp, 18% moisture, will help reduce leaf loss.
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

Within each forage species, the most important factor affecting hay quality is stage of maturity.
Stage of Maturity

- Quality
- Yield
- Best time to graze

Freshly grazed | Lush vegetative growth | Flowering and seeding
Stage of Maturity
Early Harvested Forage

Cell Wall (fiber)

Late Harvested Forage

Cell soluble (goodies)

Thin Cell Wall
Low NDF = high intake
Low ADF = high energy

Thick Cell Wall
High NDF = low intake
High ADF = low energy
Stage of Maturity

- Clover/Alfalfa
  - 1/3 Bloom

- Grasses
  - Boot Stage
Stage of Maturity

- What is the boot stage?
  - This is the stage just prior to heading out.
  - The flag leaf is fully expanded, but the seed head is not visible.
  - The seed head can be felt in the flag leaf sheath.

- Each plant's ultimate goal is survival, which is dependent on seed production
- Fall production does not contain reproductive structures
Stage of Maturity

- What is the boot stage?
The effect of stage of maturity at harvest on alfalfa hay quality.

<table>
<thead>
<tr>
<th>Stage at Harvest</th>
<th>CP (%)</th>
<th>Acid Detergent Fiber (%)</th>
<th>Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-bloom</td>
<td>21.1</td>
<td>30.2</td>
<td>63.3</td>
</tr>
<tr>
<td>Early bloom</td>
<td>18.9</td>
<td>33.0</td>
<td>62.4</td>
</tr>
<tr>
<td>Mid-bloom</td>
<td>14.7</td>
<td>38.0</td>
<td>55.4</td>
</tr>
<tr>
<td>Full bloom</td>
<td>16.3</td>
<td>45.9</td>
<td>53.2</td>
</tr>
</tbody>
</table>

Values are expressed on a dry matter basis.
The effect of age on Tifton-44 bermudagrass hay on yield and quality.

<table>
<thead>
<tr>
<th>Cutting Interval</th>
<th>Yield (lb DM/Acre)</th>
<th>CP (%)</th>
<th>Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Week</td>
<td>8539</td>
<td>19.8</td>
<td>61.8</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>8603</td>
<td>17.0</td>
<td>62.2</td>
</tr>
<tr>
<td>4 Weeks</td>
<td>8197</td>
<td>14.1</td>
<td>61.3</td>
</tr>
<tr>
<td>8 Weeks</td>
<td>13329</td>
<td>9.7</td>
<td>54.3</td>
</tr>
</tbody>
</table>

Values are expressed on a dry matter basis.
From: Mason and Burton. 1982. Agronomy Journal. 74.371
The effect of stage of maturity at harvest on timothy hay quality, animal intake, and milk yield.

<table>
<thead>
<tr>
<th>Stage at Harvest</th>
<th>CP (%)</th>
<th>Acid Detergent Fiber (%)</th>
<th>Intake (lb DM/day)</th>
<th>Intake (% body wt)</th>
<th>Milk (lb/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late Boot</td>
<td>11.3</td>
<td>35.9</td>
<td>33.3</td>
<td>2.84</td>
<td>37.5</td>
</tr>
<tr>
<td>Late Bloom</td>
<td>5.4</td>
<td>42.1</td>
<td>24.3</td>
<td>2.17</td>
<td>20.1</td>
</tr>
</tbody>
</table>

Values are expressed on a dry matter basis.
## 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, May 25</td>
<td>8.6</td>
<td>56</td>
<td>7.6</td>
<td>22.5</td>
<td>2823</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Source: Mont Montgomery
Univ. of TN
500 lb Holstein Heifers
Your goal is to harvest as much leaf area as possible.
- Harvest legumes at 1/3 to 1/2 bloom
- Harvest grasses at the boot stage
Mature Enough to Combine!
Testing Hay

- No grab samples
- Use core sampler
- 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.
Quality Quality Quality