Cereal-Grain Forages: Providing Nutrient Management Options and Dairy Forage

World Dairy Expo
Dairy Forage Seminar
October 4, 2017
Madison, WI

Wayne Coblentz
USDA-ARS
US Dairy Forage Research Center
Marshfield, WI
In Oklahoma, wheat is used primarily as a dual-purpose (forage and grain) crop, but across the border in Arkansas these production practices are completely segregated.

Forage quality is exceptionally high, but fall/winter availability often is limiting, and becomes a serious problem if the producer is heavily invested in recently weaned stocker cattle.
What can we do to maximize fall forage yield?

Fall DM Yield (lbs/acre)
Fayetteville 2004
Obvious Limitation for Fall-Grown Oat
No Regrowth Potential

Blaze Spring Oat
(no regrowth)
February 15, 2005

Armor Prograze Wheat
(regrowth)
February 15, 2005

Gunsaulis et al. (2008)
In Arkansas, forages that elongate will out-yield those that remain vegetative by about a 2:1 ratio before winter.

Oat will joint and elongate during late fall, but there is very little regrowth potential from oat after jointing.

Depending on weather, growth responses can be highly variable.
What about Wisconsin?
Management Considerations

- Ideally, it would be desirable to double-crop oats or other cereal-grain forages after harvesting corn silage, and this is possible further south (Mid-Atlantic).

- Unfortunately, Wisconsin is too far north, and the growing season is too short – if you want to harvest additional fall forage.

- In Wisconsin, a fall crop of cereal-grain forage (oats) will need to follow a summer harvest of cereals as silage or grain.

- Another option is to eliminate old stands of alfalfa early (late-July or early-August), and then plant oats.

- Either way, an opportunity exists for summer manure distribution.
Yield responses (lbs/acre) for elongated (oat) cultivars maintained the same 2:1 advantage over vegetative (wheat) cultivars.

Coblentz and Walgenbach (2010)
Yield responses for oat cultivars were opposite those expected following traditional spring establishment across a wide range of harvest dates.

Coblentz and Walgenbach (2010)
Coblentz and Walgenbach (2010)

**Variety** | 2006          | 2007          
--- | --- | --- 
Ogle | Elongated (3.8) | Heading       
Drumlin | Elongated (3.3) | Early heading  
Vista | Elongated (3.3) | Late Boot     
ForagePlus | Elongated (2.1) | Elongated     

**NDF, % DM**

![NDF Bar Chart]

**Lignin, % DM**

*Lignin concentration for traditional, spring-seeded oat at heading*

![Lignin Bar Chart]

**TDN, % DM**

![TDN Bar Chart]
Pictures worth a thousand words ......................

Coblentz et al. (2012)
So ..... Which Cultivar Do I Plant ? And When?
Effects of Planting Date and Oat Cultivar on Peak Yield of Fall-Grown Oat (Marshfield, WI; 2007-2009)

Coblentz et al. (2011)
Effects of Cultivar and Harvest Date on Interactive Concentrations of NDF (% of DM)

2007-2009

Coblentz et al. (2012)
Effects of Cultivar and Harvest Date on Interactive Concentrations of WSC (% of DM)

2007-2009

Coblentz et al. (2012)
Effects of Cultivar and Harvest Date on Interactive Concentrations of TDN (% of DM)

2007-2009

Coblentz et al. (2012)
In-Vitro Gas Production

Further Evidence of Dilution ....

S346

S202
In Vitro Gas Production

<table>
<thead>
<tr>
<th>Item</th>
<th>S202</th>
<th>S346</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting</td>
<td>1 Aug</td>
<td>1 Aug</td>
</tr>
<tr>
<td>Harvest</td>
<td>15 Sep</td>
<td>3 Nov</td>
</tr>
<tr>
<td>Height, in</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Stage</td>
<td>Veg</td>
<td>Boot</td>
</tr>
<tr>
<td>NDF, %</td>
<td>46.3</td>
<td>45.2</td>
</tr>
<tr>
<td>ADF, %</td>
<td>23.4</td>
<td>23.0</td>
</tr>
<tr>
<td>HEMI, %</td>
<td>22.9</td>
<td>22.2</td>
</tr>
<tr>
<td>CELL, %</td>
<td>21.8</td>
<td>21.4</td>
</tr>
<tr>
<td>Lignin, %</td>
<td>0.84</td>
<td>1.10</td>
</tr>
<tr>
<td>Lignin/NDF</td>
<td>0.018</td>
<td>0.024</td>
</tr>
<tr>
<td>CP, %</td>
<td>27.3</td>
<td>11.6</td>
</tr>
<tr>
<td>WSC, %</td>
<td>3.5</td>
<td>19.4</td>
</tr>
<tr>
<td>NFC, %</td>
<td>10.1</td>
<td>32.8</td>
</tr>
<tr>
<td>Ash, %</td>
<td>15.0</td>
<td>9.1</td>
</tr>
<tr>
<td>TDN, %</td>
<td>64.8</td>
<td>69.4</td>
</tr>
</tbody>
</table>

Gas Production

<table>
<thead>
<tr>
<th>Gas Production</th>
<th>S202</th>
<th>S346</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 h, mL/g</td>
<td>52</td>
<td>100</td>
</tr>
<tr>
<td>24 h, mL/g</td>
<td>92</td>
<td>145</td>
</tr>
<tr>
<td>48 h, mL/g</td>
<td>138</td>
<td>171</td>
</tr>
<tr>
<td>MAX, mL/g</td>
<td>176</td>
<td>177</td>
</tr>
<tr>
<td>$K$, /h</td>
<td>0.033</td>
<td>0.074</td>
</tr>
<tr>
<td>Lag time, h</td>
<td>1.52</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Coblentz et al. (2013)
Application of Bedded-Pack Manure (2011-2012)

Low Rate = 10.2 tons/acre (wet)
High Rate = 20.0 tons/acre (wet)

DM = 23%
N = 1.9%
Bedding Source = Wood Shavings
C/N Ratio = 22
Application of Dairy Slurry (2013-2014)

Dairy Slurry
DM = 7.8%
N = 3.1% of DM
NH₄-N = 1.3% of DM

Dairy Slurry Applied at Two Rates
High = 9000 gal/acre
Low = 4500 gal/acre
## DM Yields of Fall-Grown Oat (2013-2016)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N Application Rate</th>
<th>Bedded Pack</th>
<th>Dairy Slurry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs N/acre</td>
<td>lbs DM/acre</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>2982</td>
<td>1876</td>
</tr>
<tr>
<td>Urea</td>
<td>18</td>
<td>2650</td>
<td>2483</td>
</tr>
<tr>
<td>Urea</td>
<td>36</td>
<td>3261</td>
<td>2659</td>
</tr>
<tr>
<td>Urea</td>
<td>53</td>
<td>3160</td>
<td>3211</td>
</tr>
<tr>
<td>Urea</td>
<td>71</td>
<td>3152</td>
<td>3374</td>
</tr>
<tr>
<td>Urea</td>
<td>89</td>
<td>. . .</td>
<td>3535</td>
</tr>
<tr>
<td>Manure</td>
<td>~ 90</td>
<td>2820</td>
<td>2699</td>
</tr>
<tr>
<td>Manure</td>
<td>~ 180</td>
<td>2922</td>
<td>2939</td>
</tr>
</tbody>
</table>

Coblentz et al. 2014, 2016
Fertilizer Equivalents from Dairy Manures, 2011-2014

**Fertilizer Equivalents**
- **Dairy Slurry**
  - High Rate = 43 lbs N/acre
  - Low Rate = 31 lbs N/acre

**Fertilizer Equivalents**
- **Bedded Pack**
  - High Rate = 11 lbs N/acre
  - Low Rate = -11 lbs N/acre

*Coblentz et al. 2014, 2016*
## Net Effects of Nitrogen Fertilization with Urea or Dairy Slurry on Forage Quality (2013-2014)

Coblentz et al. 2017

<table>
<thead>
<tr>
<th>Treatment</th>
<th>WSC</th>
<th>NDF</th>
<th>ADL</th>
<th>NO$_3$-N</th>
<th>ivNDFD$_{30}$</th>
<th>uNDFD$_{240}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-------</td>
<td>% of DM</td>
<td>-------</td>
<td>ppm</td>
<td>-------</td>
<td>% of NDF</td>
</tr>
<tr>
<td>Control, 0</td>
<td>21.2</td>
<td>41.5</td>
<td>0.70</td>
<td>1</td>
<td>71.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Urea, 18</td>
<td>19.6</td>
<td>43.3</td>
<td>0.90</td>
<td>12</td>
<td>70.8</td>
<td>15.1</td>
</tr>
<tr>
<td>Urea, 36</td>
<td>17.1</td>
<td>45.3</td>
<td>0.99</td>
<td>34</td>
<td>69.2</td>
<td>14.6</td>
</tr>
<tr>
<td>Urea, 53</td>
<td>16.0</td>
<td>45.0</td>
<td>1.07</td>
<td>224</td>
<td>69.6</td>
<td>15.0</td>
</tr>
<tr>
<td>Urea, 71</td>
<td>13.5</td>
<td>47.0</td>
<td>1.09</td>
<td>343</td>
<td>69.7</td>
<td>15.7</td>
</tr>
<tr>
<td>Urea, 89</td>
<td>14.4</td>
<td>46.7</td>
<td>1.11</td>
<td>426</td>
<td>69.4</td>
<td>15.6</td>
</tr>
<tr>
<td>Manure, ~ 90</td>
<td>18.2</td>
<td>44.9</td>
<td>0.97</td>
<td>9</td>
<td>71.0</td>
<td>15.4</td>
</tr>
<tr>
<td>Manure, ~ 180</td>
<td>16.1</td>
<td>45.9</td>
<td>1.08</td>
<td>12</td>
<td>70.1</td>
<td>14.8</td>
</tr>
</tbody>
</table>

On average, these forages will lose about 0.5 percentage units of TDN for every 10 lbs N/acre applied as urea fertilizer.

Coblentz et al. 2017
A Brief Word About Fall-Seeded Mixtures

Experiment Initiated Fall 2016, Marshfield, WI

Treatments (lbs seed/acre)

- Oat (96 lbs/acre)
- Wheat (90)
- Wheat (90) + Oat (32)
- Wheat (90) + Oat (64)
- Wheat (90) + Oat (96)
- Rye (90)
- Rye (90) + Oat (32)
- Rye (90) + Oat (64)
- Rye (90) + Oat (96)
- Triticale (90)
- Triticale (90) + Oat (32)
- Triticale (90) + Oat (64)
- Triticale (90) + Oat (96)
Fall, Spring, and Total DM Yield from Cereal-Forage Mixtures with Fall-Grown Oat
## Quality of Fall-Seeded Mixtures (% of DM)

<table>
<thead>
<tr>
<th>Species</th>
<th>Rate</th>
<th>Oat Rate</th>
<th>CP</th>
<th>NDF</th>
<th>WSC</th>
<th>TDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oat</td>
<td>96</td>
<td>13.2</td>
<td>55.7</td>
<td>8.7</td>
<td>61.5</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>90</td>
<td>0</td>
<td>17.2</td>
<td>49.6</td>
<td>12.6</td>
<td>67.2</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>32</td>
<td>15.9</td>
<td>50.2</td>
<td>11.3</td>
<td>65.7</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>64</td>
<td>13.7</td>
<td>52.2</td>
<td>11.8</td>
<td>65.2</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>96</td>
<td>14.0</td>
<td>51.5</td>
<td>12.1</td>
<td>65.8</td>
</tr>
<tr>
<td>Rye</td>
<td>90</td>
<td>0</td>
<td>21.0</td>
<td>49.5</td>
<td>10.1</td>
<td>67.0</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>32</td>
<td>16.3</td>
<td>48.5</td>
<td>12.6</td>
<td>67.3</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>64</td>
<td>15.2</td>
<td>49.2</td>
<td>13.0</td>
<td>67.2</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>96</td>
<td>14.2</td>
<td>52.5</td>
<td>10.8</td>
<td>64.7</td>
</tr>
<tr>
<td>Triticale</td>
<td>90</td>
<td>0</td>
<td>17.3</td>
<td>50.1</td>
<td>10.7</td>
<td>65.9</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>32</td>
<td>15.0</td>
<td>51.8</td>
<td>10.5</td>
<td>65.2</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>64</td>
<td>14.7</td>
<td>52.3</td>
<td>10.3</td>
<td>65.2</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>96</td>
<td>13.6</td>
<td>52.6</td>
<td>10.6</td>
<td>64.3</td>
</tr>
</tbody>
</table>

Experiment Initiated Fall 2016, Marshfield, WI
Use of Triticale in Dairy Cropping Systems

- planted in the fall, usually after corn silage
- harvested in the spring as silage
- recent increase in popularity related (in part) to facilitation of manure distribution, and for providing winter ground cover

Experiment Initiated Spring 2016, Marshfield, WI
Use of Triticale in Dairy Cropping Systems

Experiment Initiated Spring 2016, Marshfield, WI
Effects of Growth Stage on Nutritive Value of Triticale

- **20-29** Tillering
- **30-39** Elongation
- **40-49** Boot
- **50-59** Heading
- **60-69** Flowering
- **70-79** Milk
- **80-89** Dough
- **90-99** Ripe

**Graphs:**

- **NDF %**
  - Equation: $Y = -0.0006x^2 + 0.086x^2 - 3.1599x + 74.8$
  - $R^2 = 0.929$

- **ADL %**
  - Equation: $Y = -0.0006x^2 + 0.13x - 2.58$
  - $R^2 = 0.833$

- **CP %**
  - Equation: $Y = 0.0043x^2 - 0.78x + 40.9$
  - $R^2 = 0.930$

- **TDN %**
  - Equation: $Y = 0.0003x^3 - 0.041x^2 + 1.66x + 50.3$
  - $R^2 = 0.615$
Leading the world in integrated dairy forage systems research

U.S. Dairy Forage Research Center

www.ars.usda.gov/mwa/madison/dfrc