Evaluating performance of corn hybrids for silage production on Wisconsin farms

J.G. Lauer, R.D. Shaver, J.G. Coors, P. Hoffman and N. DeLeon
University of Wisconsin-Madison

XVth International Silage Conference
Madison, WI
July 27-29, 2009
Rationale and Situation

- A one bushel increase by WI corn farmers increases farm income $8 to $16 million dollars.
- In 2009, 524 corn hybrids were tested at 13 locations (grain= 403, silage= 199).

Objective

- To provide unbiased performance comparisons of hybrid seed corn available in Wisconsin.
Overview

• UW Silage Consortium
  ✓ Established proof of concept

• Problems to overcome
  ✓ NIR
  ✓ Equipment
  ✓ Presentation of data – MILK2006

• Repeatability
  ✓ High v. Low Quality checks
  ✓ Estimates

• Where are we going?
  ✓ Starch digestibility
  ✓ New NDFD procedure (Combs)
Desirable Forage Characteristics

• What makes a good forage? (Carter et al., 1991)
  ✓ High yield
  ✓ High energy (high digestibility)
  ✓ High intake potential (low fiber)
  ✓ High protein
  ✓ Proper moisture at harvest for storage

• Ultimate test is animal performance
  ✓ Milk2006 is our best predictor for performance (Shaver equation)
Conclusions from UW Corn Silage Research Consortium (Coors et al., 1995)

• Ranking among corn hybrids for silage yield and quality is repeatable.

• Range among commercial WI hybrids for silage NDF and digestibility is narrow.

• Highest grain yielding hybrids are not necessarily the highest silage yielding hybrids.

• High grain-to-stover ratios do not necessarily improve silage quality, but are desired to insure adequate fermentation and preservation
UW Corn Silage Research Areas
“Where have we been?!“

- **Breeding**
  - (DeLeon, Coors)

- **Hybrid evaluation**
  - (Coors, Shaver and Lauer)

- **Management for yield AND quality**
  - Population (Cusicanqui)
  - Planting date (Darby)
  - Row spacing (Lauer)
  - Soil fertility (Bundy)

- **Harvest**
  - Timing (Darby)
  - Cutting height (Cusicanqui)
  - Special situations
    - Frost (Lauer)
    - Hail (Lauer et al.)
    - Grain equivalents / LDP (Lauer)

- **Ensiling**
  - Mycotoxins (Smiley)
  - Inoculants (Muck)
Equipment Development
2003 NIRS Global Equation Calibration

Crude protein (\%)  
N= 754  
\( R^2 = 0.91 \)

Neutral detergent fiber (\%)  
N= 754  
\( R^2 = 0.89 \)

In vitro digestibility (\%)  
N= 533  
\( R^2 = 0.79 \)

Starch content (\%)  
N= 255  
\( R^2 = 0.91 \)
Silage Performance Index (Milk2006)

Southern Late Trial 2008

Milk per Acre (lb/A)
- 24000
- 25000
- 26000
- 27000
- 28000
- 29000
- 30000
- 31000
- 32000
- 33000

Milk per Ton (lb/T)
- 2800
- 2900
- 3000
- 3100
- 3200
- 3300

Silage Performance Index (Milk2006)

Southern Late Trial 2008

Milk per Acre (lb/A)
- 24000
- 25000
- 26000
- 27000
- 28000
- 29000
- 30000
- 31000
- 32000
- 33000

Milk per Ton (lb/T)
- 2800
- 2900
- 3000
- 3100
- 3200
- 3300

http://corn.agronomy.wisc.edu

University of Wisconsin – Agronomy

Lauer © 1994-2009
# Correlation coefficients (r) of silage traits with Milk per Ton estimates

\[ N = 3727 \text{ treatment means} \]

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF</td>
<td>-0.46</td>
<td>-0.40</td>
<td>-0.94</td>
<td>-0.99</td>
</tr>
<tr>
<td>Starch</td>
<td>0.48</td>
<td>0.44</td>
<td>0.75</td>
<td>0.74</td>
</tr>
<tr>
<td>NDFD</td>
<td>0.49</td>
<td>0.70</td>
<td>0.16</td>
<td>-0.10</td>
</tr>
<tr>
<td>StarchD</td>
<td>0.30</td>
<td>0.21</td>
<td>-0.25</td>
<td>-0.27</td>
</tr>
<tr>
<td>Trait</td>
<td>N</td>
<td>Forage yield</td>
<td>NDF</td>
<td>NDFD</td>
</tr>
<tr>
<td>-----------</td>
<td>----</td>
<td>--------------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T/A</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Bmr</td>
<td>56</td>
<td>6.2</td>
<td>48.3</td>
<td>68.4</td>
</tr>
<tr>
<td>CB</td>
<td>343</td>
<td>7.9</td>
<td>46.5</td>
<td>60.2</td>
</tr>
<tr>
<td>CB, LL</td>
<td>142</td>
<td>7.9</td>
<td>46.6</td>
<td>60.2</td>
</tr>
<tr>
<td>CB, RR</td>
<td>161</td>
<td>7.8</td>
<td>46.1</td>
<td>60.0</td>
</tr>
<tr>
<td>CB, CR, RR</td>
<td>171</td>
<td>7.8</td>
<td>46.1</td>
<td>59.9</td>
</tr>
<tr>
<td>Leafy</td>
<td>96</td>
<td>7.8</td>
<td>48.2</td>
<td>59.3</td>
</tr>
<tr>
<td>RR</td>
<td>125</td>
<td>7.6</td>
<td>47.0</td>
<td>59.4</td>
</tr>
<tr>
<td>Normal</td>
<td>1304</td>
<td>7.6</td>
<td>47.1</td>
<td>60.0</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>0.8</td>
<td>2.7</td>
<td>1.8</td>
<td>3.9</td>
</tr>
<tr>
<td>Average hybrid</td>
<td>2665</td>
<td>8.0</td>
<td>46.7</td>
<td>59.8</td>
</tr>
</tbody>
</table>
## Performance of Silage Quality Check Hybrids

Criteria: 1) 5% Yield increase, 2) NDF = high v. low (1995-2006, n = 139 trials)

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Forage yield</th>
<th>NDF</th>
<th>NDFD</th>
<th>Starch</th>
<th>Milk per Ton</th>
<th>Milk per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.87</td>
<td>46.0</td>
<td>61.1</td>
<td>31.2</td>
<td>3290</td>
<td>25900</td>
</tr>
<tr>
<td>Low</td>
<td>8.12</td>
<td>48.2</td>
<td>60.8</td>
<td>28.6</td>
<td>3210</td>
<td>26100</td>
</tr>
<tr>
<td>Trial Mean</td>
<td>7.70</td>
<td>46.8</td>
<td>61.0</td>
<td>30.4</td>
<td>3260</td>
<td>25200</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.14</td>
<td>0.42</td>
<td>NS</td>
<td>0.50</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>
Materials and Methods

- Within a year, all production zones test the same set of hybrids at 2 or 3 locations (3 reps).
- Repeatability estimated using:

\[ R = \frac{V_G}{V_G + V_{GE}/e + V_e/re} \]

where \( V_G \), \( V_{GE} \), and \( V_e \) refer to variance due to genotype, genotype by environment, and error. Coefficients \( e \) and \( r \) refer to the number of environments and replications.
## Repeatability of Corn Silage Traits in Wisconsin Production Zones (1995-2008)

<table>
<thead>
<tr>
<th>Trait</th>
<th>North</th>
<th>North Central</th>
<th>South Central</th>
<th>South</th>
<th>Literature*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Early</td>
<td>Late</td>
<td>Early</td>
<td>Late</td>
</tr>
<tr>
<td>Forage yield</td>
<td>0.32</td>
<td>0.59</td>
<td>0.54</td>
<td>0.66</td>
<td>0.60</td>
</tr>
<tr>
<td>Crude protein</td>
<td>0.45</td>
<td>0.65</td>
<td>0.59</td>
<td>0.66</td>
<td>0.59</td>
</tr>
<tr>
<td>NDF</td>
<td>0.61</td>
<td>0.50</td>
<td>0.59</td>
<td>0.48</td>
<td>0.50</td>
</tr>
<tr>
<td>IVTD</td>
<td>0.64</td>
<td>0.62</td>
<td>0.64</td>
<td>0.49</td>
<td>0.53</td>
</tr>
<tr>
<td>NDFD</td>
<td>0.76</td>
<td>0.74</td>
<td>0.74</td>
<td>0.73</td>
<td>0.70</td>
</tr>
<tr>
<td>Starch</td>
<td>0.60</td>
<td>0.58</td>
<td>0.69</td>
<td>0.66</td>
<td>0.69</td>
</tr>
<tr>
<td>M06t</td>
<td>0.56</td>
<td>0.56</td>
<td>0.63</td>
<td>0.44</td>
<td>0.53</td>
</tr>
<tr>
<td>M06a</td>
<td>0.26</td>
<td>0.50</td>
<td>0.51</td>
<td>0.54</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*Values derived from Coors et al., 1996; Lorenz and Coors, 2007
Repeatability of Silage Traits in Northern Wisconsin
Repeatability of Silage Traits in Southern Wisconsin

- Milk per Acre
- Forage yield
- Milk per Ton
- NDFD
- Starch

Late trial

Repeatability


http://corn.agronomy.wisc.edu

Lauer © 1994-2009
University of Wisconsin – Agronomy
Economic savings – Why is hybrid testing important?

• Average difference between top- and bottom-performing hybrid in a trial:
  ✓ Forage yield = 3.1 T DM/A = 6.9 Mg DM ha\(^{-1}\)
  ✓ Milk per Ton = 477 lbs Milk/T DM = 238 kg Milk Mg\(^{-1}\)
  ✓ Milk per Acre = 11,500 lbs Milk /A = 12,900 kg Milk ha\(^{-1}\)

• Quality traits, especially NDFD, are repeatable so farmers can make hybrid selection decisions.
  ✓ There is a larger GxE effect on forage yield than on quality traits.
  ✓ Thus, we need more testing sites to adequately test for yield relative to quality.
The End For Now – Questions?
Thanks for your attention!

Jorge Cusicanqui  Kent Kohn  Jim Coors
Heather Darby  Thierno Diallo  Randy Shaver
Palle Pedersen  Keith Hudelson  Natalia De Leon
Trenton Stanger  John Gaska  Pat Hoffman
Zhe Yan  Tim Wood  Johnny Pendleton
Justin Hopf  Dwight Mueller  Paul Carter
Steve Wilkens  Darwin Frye  Roger Higgs

Funding Sources: Wisconsin Corn Promotion Board, Wisconsin Corn Growers Association, Seed Companies, USDA-Hatch, National Crop Insurance Services

Photo by Justin Hopf