Growing High Quality Corn Silage

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Desirable Corn Silage Characteristics

- What makes a good corn silage?
  - High yield
  - High energy (high digestibility)
  - High intake potential (low fiber)
  - High protein
  - Proper moisture at harvest for storage

- Both **hybrid selection** and **management** are critical for high quality silage production
Corn Silage Hybrid Selection

- Hybrid performance data
  - Trustworthy data, replicated, over locations and/or years
  - Consistent top performance in your region (reduces risk)

- Evaluate both yield and quality
  - **Yield** (on % DM basis)
  - NDF: Low NDF increases silage digestibility and intake
  - NDF digestibility (NDFD): increase DM intake and milk production
  - High Crude protein, Starch content
  - Overall Silage quality (**Milk/ton** is a good indicator)
  - **Milk/Acre** (DM yield x Milk/ton)
  - Goal: Identify hybrids with **high yield & milk/ton**
Importance of Hybrid Selection
Importance of Hybrid Selection

- **Dry tonnage**: 25% diff b/w best and worst hybrid
- **Milk per Acre**: 11% diff b/w best and worst hybrid
- **Milk per Ton**: 30% diff b/w best and worst hybrid

- Assume 5,000 ton corn silage feed requirement
- 42 acres x 150 bu/A = 6,300 bu (to sell or feed)
- 6,300 bu x $3.50/bu = $22,050

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Silage yield (T/A @65%)</th>
<th>Acres required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid A</td>
<td>30</td>
<td>167</td>
</tr>
<tr>
<td>Hybrid B</td>
<td>24</td>
<td>208</td>
</tr>
<tr>
<td>Difference</td>
<td>6</td>
<td>42</td>
</tr>
<tr>
<td>Diff. (%)</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Michigan Corn Trials (2015 onwards)
Corn Maturity Selection - GDD maps

- Seasonal GDD totals are increasing with time, use GDD rating vs “relative maturity”?
- ~5-8 units longer ‘relative maturity’ than grain hybrids

May 1- Sept 30 (86/50 method)
Relationships with Relative Maturity

Data from Zone 4 (3 locations)- One planting time: mid-season

- 2020
  - Dry Yield (t/ac) vs. Relative Maturity (d)
    - Equation: y = 0.0443x + 4.502
    - R² = 0.0556
  - Milk per Ton vs. Relative Maturity (d)
    - Equation: y = -7.8463x + 4156.2
    - R² = 0.0737

- 2018
  - Dry Yield (t/ac) vs. Relative Maturity (d)
  - Milk per Ton vs. Relative Maturity (d)
  - Milk per Acre vs. Relative Maturity (d)
### Silage Dry Yield of Hybrids with Transgenic Traits

<table>
<thead>
<tr>
<th></th>
<th>All entries</th>
<th>Conv. Only</th>
<th>Herbicide tolerance only</th>
<th>Above ground insect protection</th>
<th>Above and below ground insect protection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Av. Yield (t DM/A)</strong></td>
<td>9.7</td>
<td>9.5</td>
<td>9.5</td>
<td>9.8</td>
<td>9.7</td>
</tr>
<tr>
<td><strong>Range (t DM/A)</strong></td>
<td>8.3-10.9</td>
<td>8.9-10.6</td>
<td>8.3-10.5</td>
<td>9.0-10.7</td>
<td>8.6-10.9</td>
</tr>
<tr>
<td><strong>No. of hybrids</strong></td>
<td>165.0</td>
<td>13 (8%)</td>
<td>9 (5%)</td>
<td>67 (41%)</td>
<td>76 (46%)</td>
</tr>
<tr>
<td><strong>3-yr Av. Yield</strong></td>
<td>9.1</td>
<td>8.8</td>
<td>8.8</td>
<td>9.1</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Includes herbicide tolerance

What if Mycotoxins (VOM) are an issue?

Pest pressure is mostly absent in these trials.
## Corn Silage Hybrid Types

<table>
<thead>
<tr>
<th>Hybrid type</th>
<th>DM Yield (tons/ac)</th>
<th>Quality (% of DM)</th>
<th>Milk Yield (lb/ton)</th>
<th>Milk Yield (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Starch</td>
<td>CP</td>
<td>NDF</td>
</tr>
<tr>
<td>Dual Purpose Avg:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DeKalb DKD61-69</td>
<td>9.9 a</td>
<td>34 a</td>
<td>8.4 b</td>
<td>40 b</td>
</tr>
<tr>
<td>DeKalb DKC63-42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pioneer 33T55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pioneer 34A89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown Midrib Avg:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mycogen F2F566</td>
<td>9.2 b</td>
<td>32 b</td>
<td>8.6 a</td>
<td>42 a</td>
</tr>
<tr>
<td>Mycogen F2F610</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference:</td>
<td>-7%</td>
<td>-6%</td>
<td>+2%</td>
<td>+5%</td>
</tr>
</tbody>
</table>

**Notes on BMR:**
-20% in 1990s Similar in 1990s

Data from Cox & Cherney, 2011 *(Agronomy Journal)*
Corn Silage Hybrid Types- Dry matter

- Highest yield in Dual hybrid, similar to HiDF and Leafy hybrid
- BMR hybrids had lower yield than Dual in 3 out of 4 site years
- Similar response to seeding rates among hybrid classes
Lower NDFD in Dual hybrid compared to BMR

BMR hybrid had highest NDFD
Corn Silage Hybrid Types - Milk yields

**2018**

- **Dual**
  - Huron: 30000 lbs/acre
  - Ingham: 35000 lbs/acre

- **BMR**
  - Huron: 32000 lbs/acre
  - Ingham: 26000 lbs/acre

- **Leafy**
  - Huron: 33000 lbs/acre
  - Ingham: 27000 lbs/acre

- **HiDF**
  - Huron: 34000 lbs/acre
  - Ingham: 28000 lbs/acre

**2019**

- **Dual**
  - Huron: 31000 lbs/acre
  - Ingham: 25000 lbs/acre

- **BMR**
  - Huron: 33000 lbs/acre
  - Ingham: 27000 lbs/acre

- **Leafy**
  - Huron: 34000 lbs/acre
  - Ingham: 28000 lbs/acre

- **HiDF**
  - Huron: 35000 lbs/acre
  - Ingham: 29000 lbs/acre
Planting Date

- Early Planting resulted in higher silage/grain yield and quality
- Yield and quality declines with delayed planting
Early: May 7  
Mid: May 22  
Late: June 7  
Hybrid: 109 RM
Seeding Rates

![Graph](image_url)

- **Relative measure (%)**
  - Grain yield (R2=0.92)
  - Forage yield (R2=0.87)
  - Milk per ton (R2=0.73)
  - Milk per acre (R2=0.83)

- **Harvested plant density (x 1000)**

Joe Lauer, 2018
Seeding Rates

- Trials in 2018-2019 showed minimal differences in seeding rate responses between hybrid types (NO hybrid x seed rate interaction)
- Optimal seed rate $\geq 36k/\text{ac}$, $\sim 3,000$ more than corn grain
- Some benefit of narrow rows in northern Corn Belt

![Graph showing dry yield vs seed rate]

\[ y = 4E-05x + 7.4721 \]
\[ R^2 = 0.2078 \]
Harvest at Peak Quality

Peak 1: max dNDFD

Peak 2: max Starch content

Source: Joe Lauer, UW (2019)
Optimal Harvest Considerations

- Allow dry down to 65-70% whole-plant moisture (60-65% in upright silos)
- Poor relationship between kernel milk-line stage and whole-plant %DM
- Use kernel milk-line as trigger to begin sampling for whole-plant %DM
- Begin around full-dent stage (~35 d after silking; half milk-line is ~45 d after silking)
- ~0.5% per day dry-down on a whole-plant basis
- Kernel processing is important
Mycotoxins in Corn Silage

Gibberella Ear and Stalk Rot
DON (VOM), ZON

Fusarium Ear and Stalk Rot
Fumonisin

Grad student: H. Kaur

Source: Damon Smith, UW
## Mycotoxin Dietary Limits

<table>
<thead>
<tr>
<th>Potentially Harmful Toxin Levels for a Total Diet (DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxin Type</strong></td>
</tr>
<tr>
<td>Aflatoxin</td>
</tr>
<tr>
<td>Deoxynivalenol (DON or Vomitoxin)*</td>
</tr>
<tr>
<td>Fumonisin</td>
</tr>
<tr>
<td>T-2 Toxin</td>
</tr>
<tr>
<td>Zearalenone</td>
</tr>
<tr>
<td>Ochratoxin</td>
</tr>
<tr>
<td>Ergot Toxins (combined)</td>
</tr>
</tbody>
</table>

**Total Diet DON Level = Feedstuff DON Level X (Feedstuff (lbs. DM) / Total Diet (lbs. DM))**

*e.g. Total Diet DON 2.5 ppm = 5.0 ppm (Corn Silage DON level) X (25 lbs. DM Corn Silage / 50 lbs. DM Total Diet)*

Source: John Goeser (2015)
Mycotoxins in Michigan Fields - 2019 data

- 34 samples tested for 24 toxins, >1 mycotoxin in all, most samples had multiple toxins
- DON and ZON were reported in all samples (co-occurrence was common)
- Low levels overall for most toxins but DON was >1ppm in ~50% samples
- Environment was not conductive to fungal growth and toxin accumulation in 2019 and 2020

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>DON</th>
<th>D3G</th>
<th>15-ADON</th>
<th>CUL</th>
<th>ZON</th>
<th>HT2</th>
<th>FB1</th>
<th>FB2</th>
<th>FB3</th>
<th>BEAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive samples</td>
<td>34</td>
<td>27</td>
<td>21</td>
<td>33</td>
<td>34</td>
<td>8</td>
<td>33</td>
<td>28</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>Percent positives</td>
<td>100</td>
<td>79</td>
<td>62</td>
<td>97</td>
<td>100</td>
<td>24</td>
<td>97</td>
<td>82</td>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>Highest levels (ppm)</td>
<td>5.34</td>
<td>0.76</td>
<td>1.59</td>
<td>0.54</td>
<td>2.69</td>
<td>0.59</td>
<td>2.76</td>
<td>0.69</td>
<td>0.67</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Hybrid Selection and Insect Protection Traits

<table>
<thead>
<tr>
<th>Hybrid Insect Protection Trait</th>
<th>Western Bean Cutworm (WBC) Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>AB</td>
</tr>
<tr>
<td>ECB</td>
<td>A</td>
</tr>
<tr>
<td>ECB + WBC</td>
<td>B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hybrid Insect Protection Trait</th>
<th>WBC Severity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>AB</td>
</tr>
<tr>
<td>ECB</td>
<td>A</td>
</tr>
<tr>
<td>ECB + WBC</td>
<td>B</td>
</tr>
</tbody>
</table>

ECB- European Corn Borer; WBC- Western Bean Cutworm
Average of 2 hybrids/category, 5% RIB (refuge in bag) for Bt hybrids
Hybrid Selection and Insect Protection Traits

**Ear Rot Index (%)**

- None
- ECB
- ECB + WBC

**Western Bean Cutworm Incidence (%)**

- ECB
- ECB + WBC

Graph showing the relationship between hybrid insect protection traits and ear rot index, with R² = 0.537.
Hybrid Selection and Insect Protection Traits

Ingham 2019 (Inoculated Study)
- No benefit of fungicide application in 2019
- 2020 showed reduction in ear rot levels at 2 locations, DON results are pending
- Other research has shown reduction in foliar and stalk rots, improved quality
Integrated Mycotoxin Management

- Hybrid selection
- Residue management
  - Crop rotation
  - Tillage
- Reduce plant stress
- Manage for uniformity
- Insect control (Bt traits, scout and spray)
- Fungicide application (timing, chemistry)
- Harvest high risk fields first
- Diet: dilute, add adsorbents?
Summary

- Hybrid selection considerations:
  - High silage yield and quality
  - Relative maturity (match local GDD)
  - Trait package- based on pest pressure
  - Dual vs silage type hybrids?
  - Agronomic traits- disease/drought tolerance

- Key management decisions:
  - Early planting
  - Optimum seeding rate ($\geq 36,000$ seeds/ac)
  - Harvest at peak quality
  - Fungicide/insecticide application?
  - Mycotoxin management
Thanks!

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Project GREEEN
Michigan Alliance for Animal Agriculture
MMPA
Michigan State University Extension

Seed companies

- Harkirat Kaur
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- Maddi Yaek
- Garrett Zuver
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- Paul Horny
- Charles Scovill (Syngenta)
- Undergrad students
- Farmer cooperators

- Phil Kaatz
- Phil Durst
- Martin Manguard
- Brook Wilke
- Farmer cooperators

- Dr. Chris Difonzo
- Dr. Marty Chilvers
- Dr. Erin Burns

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