Non GMO Crop Production

Joe Lawrence
Crops of Potential Interest: DAIRY

Field Crops where certain varieties/hybrids contain GE Traits

- Corn
- Alfalfa
- Soybean

- Cotton
- Canola
- Sugar Beets

Conventional – term often used to describe a crop variety/hybrid that does not contain a GE Trait

**Conventional ≠ non-GMO compliant**
Field Corn

<table>
<thead>
<tr>
<th>Genetically Engineered</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbicide Tolerance</strong></td>
<td>• Brown Mid Rib (BMR)</td>
</tr>
<tr>
<td>Glyphosate tolerance</td>
<td>• Floury Starch Silage Hybrids</td>
</tr>
<tr>
<td>Roundup Ready (RR)</td>
<td>• Disease Tolerance</td>
</tr>
<tr>
<td>Glyphosate Tolerant (GT)</td>
<td>• Drought Tolerance</td>
</tr>
<tr>
<td>Glufosinate tolerance</td>
<td><em>SOMETIMES, check with seed supplier</em></td>
</tr>
<tr>
<td>Liberty Link (LL)</td>
<td></td>
</tr>
<tr>
<td>2,4-D tolerance</td>
<td></td>
</tr>
<tr>
<td>Enlist</td>
<td></td>
</tr>
<tr>
<td>Dicamba tolerance</td>
<td></td>
</tr>
<tr>
<td>Roundup Ready Plus Extend</td>
<td></td>
</tr>
<tr>
<td><strong>Bt Insect Protection</strong></td>
<td></td>
</tr>
<tr>
<td>Corn Rootworm</td>
<td></td>
</tr>
<tr>
<td>Lepidoptera (Moths &amp; Butterflies)</td>
<td></td>
</tr>
<tr>
<td><strong>Drought Tolerance</strong></td>
<td></td>
</tr>
<tr>
<td><em>SOMETIMES, check with seed supplier</em></td>
<td></td>
</tr>
</tbody>
</table>

*SOMETIMES, check with seed supplier*
# Soybeans

<table>
<thead>
<tr>
<th>Genetically Engineered</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbicide Tolerance</strong></td>
<td><strong>Disease Tolerance</strong></td>
</tr>
<tr>
<td>Glyphosate tolerance</td>
<td>High Oleic</td>
</tr>
<tr>
<td>Roundup Ready (RR or RR2)</td>
<td><em>SOMETIMES, check with seed supplier</em></td>
</tr>
<tr>
<td>Glyphosate Tolerant (GT)</td>
<td></td>
</tr>
<tr>
<td>Glufosinate tolerance</td>
<td></td>
</tr>
<tr>
<td>Liberty Link (LL)</td>
<td></td>
</tr>
<tr>
<td>2,4-D tolerance</td>
<td></td>
</tr>
<tr>
<td>Enlist</td>
<td></td>
</tr>
<tr>
<td>Dicamba tolerance</td>
<td></td>
</tr>
<tr>
<td>Roundup Ready Plus Xtend</td>
<td></td>
</tr>
<tr>
<td><strong>High Oleic</strong></td>
<td><strong>SOMETIMES, check with seed supplier</strong></td>
</tr>
</tbody>
</table>

*Sometimes, check with seed supplier*
## Alfalfa

<table>
<thead>
<tr>
<th>Genetically Engineered</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbicide Tolerance</strong></td>
<td>• High Quality (HQ)</td>
</tr>
<tr>
<td>Glyphosate tolerance</td>
<td>• Low Lignin (other than HarvXtra)</td>
</tr>
<tr>
<td>Roundup Ready (RR)</td>
<td>• Hybrid</td>
</tr>
<tr>
<td><strong>Low Lignin</strong></td>
<td>• Multifoliate</td>
</tr>
<tr>
<td>HarvXtra*</td>
<td>• Potato Leafhopper Tolerance</td>
</tr>
<tr>
<td></td>
<td>• Alfalfa Snout Beetle Tolerance</td>
</tr>
<tr>
<td></td>
<td>• Disease Tolerance</td>
</tr>
<tr>
<td></td>
<td>• Branch Rooted</td>
</tr>
</tbody>
</table>

*Currently all HarvXtra alfalfa is also RR*
Farm Transition: Seed / Crop Selection

- Communication is Critical
- Begin the process **early**
- Hybrid/Variety selection (at least initially) may be more limited
  - Relative Maturities
  - Desired traits
- Pre-order of additional seed treatment
- Seed companies need very clear guidelines for what will meet the definition of “GMO Free” based on the standard their customers may be subject to.
Chain of Command and Compliance Risk

Crops grown for grain or forage need to have significant documentation to meet project standard.

- Seed Production
- Crop Production
- Feed Management

“Traceability, segregation, and cleanout procedures from the point of testing to feeding the herd must be approved by the TA.”

Risk for all parties in chain of command but at the end of the day the largest risk falls on the farmer marketing their product.
Integrated Pest Management (IPM) principals encourages data driven decision making to match the best management tool to the situation

- Cultural Control
- Biological Control
- Chemical Control
- GE Control
- No Control

- In some cases pest are below an economic threshold where the cost of control is higher than the expected return
Farm Transition:
Field/Crop Needs

- Life Cycle of Insect Pest
  - Corn Rootworm
  - Western Bean Cutworm

- Predominant Weed Populations
  - Annuals vs. Perennials
  - Grass vs. Broadleaf
  - Time of emergence

- Stage of Rotation (Years in Corn)
  - Rootworm

- Grain vs Silage
  - Corn Borer

- Tillage Practices
  - Early season insect pest
  - Biennial, perennial weeds
Asking the right questions

Pest Protection Needs

• What is the pest life cycle?
  • Affecting crop this year or next year?

• What pest are problematic in your area
  • Western Bean Cutworm populations are spotty in NY
  • Localized disease issues
    • River Valley areas
Farm Transition: Herbicide Program

- Emphasis on **PRE**-Emergence herbicide programs
  - Cost and effectiveness of rescue treatments highly variable
- Need to get the right ingredients in the mix
  - Previous year scouting records
  - What weeds were problematic

Get out and SCOUT!

http://www.fresnostate.edu/jcast/weedscience/weedseedling.html
Farm Transition: Crop Rotation

• Management of Pest
  • Shorten consecutive years of corn
    • Assess acreage needs and suitability
    • Soil Management, Topography
    • Reconfigure fields (strip cropping)

• Residual Herbicide
  • Several herbicide options present for non-HT corn have longer residual times in the soil and may also carry additional crop rotation restrictions.
Asking the right questions

More than just Pest Protection

- Overall Hybrid Performance
  - Silage Forage Quality
  - How does it fit with your overall crop rotation and feeding program
- Test Weight
- Stand ability
- Disease Tolerance
- Suitability to soil type

Sources of information
(in no particular order, all valuable)
- Personal Experience
- Company Data
- NY Corn Silage Hybrid Trials
- NY Corn Grain Hybrid Trials
- Data from other Universities

- Important to utilize more than one source
- Multiple locations and years of data allows for confidence in decision making
Farm Transition: Field Equipment

• Tillage
• Corn Planter – Insecticide Boxes*
  • Corn Rootworm

• Spray Equipment – High Clearance
  • Western Bean Cutworm
  • Corn Rootworm

* Farm Staff with Pesticide Applicators Licenses

Farm Transition: Field Buffers

- Primarily a concern for Corn in Northeast
- Slightly higher concern in grain
  - 1 pollen = 1 kernel
- Considerations (Dr. Elson Shields, 2017)
  - 8-10% of pollen escapes to the upper atmosphere and moves miles.
    - Pollen only remains viable for a few hours
  - Silks emerge a couple of days before local pollen shed. This window is where contamination happens.
  - Seed production fields are separated by a minimum of 2 miles and still suffer 2-5% contamination.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Self-pollinated</th>
<th>Cross-pollinated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Soybeans</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Canola</td>
<td></td>
<td>X</td>
</tr>
</tbody>
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Farm Transition: Field Buffers

- Field Buffers
  - No guaranteed distance
  - Many suggest referencing distances used in certified seed production

- Communication with neighbors.

- “Temporal separation is the best.”
  - “Plant your non-GE fields first, ahead of the neighbors so when the silks emerge, there is no pollinating corn around.”

- Dr. Elson Shields, 2017

### Minimum Land, Isolation, Field, and Seed Standards

<table>
<thead>
<tr>
<th>Crop</th>
<th>Isolation Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foundation</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>1,320 (hybrid)</td>
</tr>
<tr>
<td>Hybrid Corn</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td>0</td>
</tr>
<tr>
<td>Cotton</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2640 (hybrid)</td>
</tr>
<tr>
<td>Rape (Canola)</td>
<td>1320 (cross)</td>
</tr>
<tr>
<td></td>
<td>660 (self)</td>
</tr>
</tbody>
</table>

https://www.law.cornell.edu/cfr/text/7/201.76
Farm Transition: Production Potential

• Row Crops – Under optimum conditions conventional varieties/hybrids have yield potential equivalent to GE

• GE technology has helped to close the gap between yield potential and actual yield - National Academies of Sciences, Engineering, and Medicine, 2016
  • Reduces incidences of yield loss from stressors
    • Pest
    • Weather
Farm Transition: Production Potential

• *Alfalfa* – the introduction of quality improvements from GE has shifted the discussion away from just yield per acre

• Potential for increased production variability with conventional crops may warrant additional acreage to assure adequate feed inventories
Farm Transition: Pest Damage & Feed Quality

Potential impacts of insect damage
- Overall Yield
- Harvest Challenges
- Plant Health
- Rate of Dry Down
- Reduction in Grain content
- Physical injury opens door for molds
  - potential to develop mycotoxins*

*Evidence of strong correlation is lacking, Work in this area on-going
2017 NYS & VT Corn Silage Trial Program

Western Bean Cutworm and Mycotoxin Screening

• Madrid and Aurora, NY
  • Assessed plots for ear damage prior to harvest
  • At harvest collected samples for Mycotoxin screening
• 3 toxins showed up in trials
  • Vomitoxin
  • 15-Acetyl DON
  • Zearalenone

<table>
<thead>
<tr>
<th>Fungal Species</th>
<th>Toxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspergillus</td>
<td>Aflatoxin B1, ppb</td>
</tr>
<tr>
<td></td>
<td>Aflatoxin B2, ppb</td>
</tr>
<tr>
<td></td>
<td>Aflatoxin G1, ppb</td>
</tr>
<tr>
<td></td>
<td>Aflatoxin G2, ppb</td>
</tr>
<tr>
<td>Fusarium</td>
<td>Vomitoxin, ppm</td>
</tr>
<tr>
<td></td>
<td>3-Acetyl DON, ppm</td>
</tr>
<tr>
<td></td>
<td>15-Acetyl DON, ppm</td>
</tr>
<tr>
<td></td>
<td>T-2, ppm</td>
</tr>
<tr>
<td></td>
<td>Zearalenone, ppm</td>
</tr>
</tbody>
</table>
Western Bean Cutworm and Mycotoxin Screening

<table>
<thead>
<tr>
<th></th>
<th>Aurora</th>
<th>Madrid</th>
</tr>
</thead>
<tbody>
<tr>
<td># Hybrids</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td># Hybrids with WBC Damage</td>
<td>14 (28.6%)</td>
<td>32 (65.3%)</td>
</tr>
<tr>
<td>Hybrids with a Positive Mycotoxin Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Hybrids</td>
<td>17 (34.6%)</td>
<td>19 (38.8%)</td>
</tr>
<tr>
<td>NO WBC Damage</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>WBC Damage Present</td>
<td>4</td>
<td>13</td>
</tr>
</tbody>
</table>
Western Bean Cutworm and Mycotoxin Screening

• In this survey, no clear link between WBC Damage and Mycotoxin development.

• A very wet year
  • “Given adequate moisture at silk emergence, F. graminearum can infect corn ears through the silk channel without any insect or other type of injury.” – G. Bergstrom, 2017
Weather Conditions

Madrid, NY

Aurora, NY

Silking

Growing Degree Days

Precipitation

Rainfall (inches)

GDD (86/50)
Western Bean Cutworm and Mycotoxin Screening

• It would appear weather conditions were more relevant than WBC damage in Mycotoxin development.

• Monitoring this over additional growing seasons will provide better insight.
  • A different pattern might appear in a year less conducive for silk channel infection.” – G. Bergstrom, 2017
Farm Transition: Production Cost

**Corn**
- Conventional *can* have a lower production cost; however, small deviations can erase the difference
  - Weed Control
    - Post emergence control of grass weeds
  - Insecticide
    - Seed Treatment
    - Rescue application

**Soybeans, Cotton, Canola** – more consistent monetary benefits with GE

**Alfalfa (Low Lignin)** – studies suggest value of increased quality far exceeds increased seed cost

### 2017 Corn Budget *

<table>
<thead>
<tr>
<th></th>
<th>Total Cost ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMO</td>
<td>$638.42</td>
</tr>
<tr>
<td>Non-GMO</td>
<td>$618.85</td>
</tr>
</tbody>
</table>

* Source: University of Missouri
Future Considerations

• Current market opportunities vs. Protecting production technology
• Stewardship & preservation of technology
• Increasing variability in growing conditions
• Future applications beyond pest management

• The production success and profitability of non GMO crop markets will be very farm specific
  • Need to thoroughly evaluate your production system and potential premiums
Responsible management of technologies used in crop production requires;

- continual advancement of technologies,
- sound and on-going scientific review of their safety and effectiveness,
- producer accountability in proper use of technologies,
- public confidence in the scientific process,
- food chain support of sound production practices.

The impacts of preserving or losing this technology go far beyond its current applications in field crop production.
Thank You!