Cropping Considerations for Herds Considering non-GMO Production

Joe Lawrence, Cornell University PRO-DAIRY

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Genetically Engineered Field Crops

GE Crop – a crop that has genetic material inserted to provide a specific characteristic to the crop
• Commonly done in field crops for
  • Herbicide Tolerance (HT)
  • Insect Pest Tolerance (Bt)
  • Drought Tolerance (in some cases)
• More recent examples moving beyond pest tolerance
  • Low Lignin (High Quality) Alfalfa

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 certified
### Field Corn

<table>
<thead>
<tr>
<th>Genetically Engineered</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicide Tolerance</td>
<td>• Brown Mid Rib (BMR)</td>
</tr>
<tr>
<td>Glyphosate tolerance</td>
<td>• Low Lignin</td>
</tr>
<tr>
<td>Roundup Ready (RR)</td>
<td>• Alfalfa Snout Beetle Tolerance</td>
</tr>
<tr>
<td>Glyphosate Tolerant (GT)</td>
<td>• Disease Tolerance</td>
</tr>
<tr>
<td>Glufosinate tolerance</td>
<td>• Disease Tolerance</td>
</tr>
<tr>
<td>Liberty Link (LL)</td>
<td>• Drought Tolerance</td>
</tr>
<tr>
<td>2,4-D tolerance</td>
<td>• SOMETIMES, check with seed supplier</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>Bt Insect Protection</td>
<td></td>
</tr>
<tr>
<td>Corn Rootworm</td>
<td></td>
</tr>
<tr>
<td>Lepidoptera (Moths &amp; Butterflies)</td>
<td></td>
</tr>
<tr>
<td>Drought Tolerance</td>
<td></td>
</tr>
<tr>
<td>SOMETIMES, check with seed supplier</td>
<td></td>
</tr>
</tbody>
</table>

### Alfalfa

<table>
<thead>
<tr>
<th>Genetically Engineered</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicide Tolerance</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>Low Lignin</td>
<td>• Multifoliate</td>
</tr>
<tr>
<td>HarvXtra*</td>
<td>• Potato Leafhopper Tolerance</td>
</tr>
<tr>
<td>SOMETIMES, check with seed supplier</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: GE & The IPM Toolbox

- 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: Seed / Crop Selection

- 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.
**Farm Transition: Understanding Pest Populations**

- Life Cycle of Insect Pest
  - Corn Rootworm
  - Western Bean Cutworm
- Predominant Weed Populations
  - Annuals vs. Perennials
  - Grass vs. Broadleaf
  - Time of emergence

**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.

**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.
  - 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.

**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**

- 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

**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: 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

*Table: Minimum Land, Isolation, Field, and Seed Standards - 7CFR 319.36

<table>
<thead>
<tr>
<th>Crop</th>
<th>Minimum Isolation Distance in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>1200 (Hybrid)</td>
</tr>
<tr>
<td>Hybrid Corn</td>
<td>600</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0</td>
</tr>
<tr>
<td>Cotton</td>
<td>0</td>
</tr>
<tr>
<td>Rape (Canola)</td>
<td>1500 (Hybrid)</td>
</tr>
</tbody>
</table>

[https://www.law.cornell.edu/cfr/7/7CFR319.36](https://www.law.cornell.edu/cfr/7/7CFR319.36)
**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

<table>
<thead>
<tr>
<th>2017 Corn Budget *</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
  - Introducing tannins into the alfalfa plant that would slow the rate of protein degradation in the rumen, thereby increasing the bypass protein available from the plant (Mark McClaslin, 2016)

**Thank You!**

Joe Lawrence, MS, CCA  
Dairy Forage Systems Specialist  
Cornell University PRO-DAIRY  
jrl65@cornell.edu  
315-778-4814  
http://prodairy.cals.cornell.edu/
Resources

- 2017 Crop Budgets
  University of Missouri
  http://extension.missouri.edu/scott/crop-budgets.aspx

- GMO CONTAMINATION PREVENTION What Does it Take?
  University of Minnesota
  http://www.extension.umn.edu/garden/master-gardener/volunteers/teaching-tools/docs/minimizing_gmo_contamination.pdf

- Managing “Pollen Drift” to Minimize Contamination of Non-GMO Corn
  The Ohio State University
  https://ohioline.osu.edu/factsheet/agf-153

- What Crop Traits are Genetically Engineered (or GMO)?
  Cornell University