WHY LIGNIN?

• Lignin is an indigestible phenolic compound in alfalfa cell walls
• As alfalfa matures, lignin content increases.
• Lignin cross-links with cellulose which decreases digestibility of fiber (dNDF)
• A 10% increase in fiber digestibility
  – Increase milk/beef by $350M/yr
  – Decrease manure by 2.8M T/yr
LIGNIN BIOSYNTHETIC PATHWAY

Dr. Richard Dixon

Suppress lignin expression through gene silencing
Reduced Lignin – Roundup Ready line

Roundup Ready only (Isoline)

May 30, 2007
Proof of Concept Reduced Lignin Alfalfa

Two period crossover design
12 multiparous cows in each period
  6 cows/treatment/period
  60 to 200 days in milk
  > 90 lbs milk
  Switched (crossover) in second period

Down-regulated lignin hay significantly increased NDF digestibility
REDUCED LIGNIN ALFALFA
CHANGES IN NDF DIGESTIBILITY OVER TIME

RL Alfalfa = Increased flexibility in harvest timing

NDFD% vs Harvest Stage

- Reduced lignin
- Isoline

Early bud, Late bud, 10% bloom
CUTTING MANAGEMENT TEST

- Compare harvest at 28 vs 35 day harvest schedule.
  - Reduced Lignin + Roundup Ready© alfalfa versus commercial varieties
  - Measure yield, persistence and forage quality
- 2010 trial at West Salem, WI
- 2011 trials at six locations
WSALEM, WI 2011
CUTTING MANAGEMENT TRIAL

28 Day Harvest

35 Day Harvest
FGI 2010 CUTTING MANAGEMENT

Reduced Lignin yield = Competitive Checks

2011 Yield - Lbs per Plot

2012 Yield - Lbs per plot

RL/RRA  54H11  Lib RR

35 day
28 day

Consortium for Alfalfa Improvement
2011-12 COMBINED DATA
Late cut Quality Reduced Lignin > Early Cut Quality of Competitive Checks

% Lignin

<table>
<thead>
<tr>
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<th>35 day</th>
<th>28 day</th>
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NDFD

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</table>

Consortium for Alfalfa Improvement
2011 RL CUTTING MANAGEMENT TEST
TOUCHET, WA

Six Harvests

Five Harvests

Spring Regrowth: 03-05-2013

1st cut 5/9 = 3.60 T/A

1st cut 5/15 = 4.55 T/A
SUMMER SLUMP IN ALFALFA

- **Reduction in yield due to:**
  - Fall dormancy response
    - Shorter day length = reduced growth
      - especially in FD 3-5 groups
  - High temperatures

- **Reduction in quality due to:**
  - High temperatures
  - Increased lignification
**FALL DORMANT** REDUCED LIGNIN EXP’S 4 LOCATION
AVERAGE JULY HARVESTS FORAGE YIELD AND QUALITY

### Average July Harvests Forage Yield and Quality

- **% Checks**: 12-18% Increase in RFQ

### Harvest Xtra Exp’s

<table>
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<tr>
<th>Entry</th>
<th>07/23/14 RFQ</th>
<th>Mt. Joy, PA DMT/A</th>
<th>07/09/14 RFQ</th>
<th>Boone, IA DMT/A</th>
<th>07/23/13 RFQ</th>
<th>Nampa, ID DMT/A</th>
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<tr>
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In an effort to bring the industry’s first quality-enhancing trait to market, FGI has announced that the reduced lignin trait will be known as HarvXtra™ alfalfa.
HARVXTRA™ ALFALFA UPDATE

- 10-15% increase in whole plant NDFD*
- RL/RRA trait purity > 90% trait purity both traits
- Competitive agronomic performance
  - Excellent forage yield
  - No increase in lodging incidence
  - Pest resistance, winter survival & persistence best in class

*NDFD should not be interpreted as a direct measurement or prediction of animal performance potential, but simply as one of several forage quality metrics commonly used by the forage community.
COMMERCIAL VARIETIES IN WIDE SCALE PRODUCT TESTING 2013-2015

- Over 150 New experimental varieties
  - Private and University Testing in >60 trials in ten states plus Mexico & Argentina
BENEFITS OF HARVXTRA™ ALFALFA

- For growers today, harvest timing is a critical decision in determining quality for alfalfa forage.
- HarvXtra™ alfalfa gives growers the option to:
  - maintain harvest schedule routines to obtain forage that is likely to meet or exceed the intended forage quality,
  OR
  - delay a harvest a few days to obtain higher tonnage without sacrificing acceptable forage quality.
HARVXTRA™ ALFALFA TIMELINE

- HarvXtra™ alfalfa was recently deregulated by the United States Department of Agriculture (USDA).
- It is not currently available for sale and is still pending regulatory approvals in key export markets with functioning regulatory systems.
- We anticipate a limited introduction in 2016 to allow growers the opportunity to experience the value and benefit of the technology.
BREEDING FOR SALINITY TOLERANCE IN ALFALFA
## RELATIVE CROP SALINITY TOLERANCE RATING*

- **Sensitive:** < 1.3 ds/m
- **Mod. Sensitive:** 1.3 – 3.0 ds/m
- **Mod. Tolerant:** 3.0 – 6.0 ds/m
- **Tolerant:** 6.0 – 10.0 ds/m
- **Unsuitable:** > 10.0 ds/m

*Soil salinity (ECe) at which yield loss begins

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SALINITY IMPACT ON CROP YIELD

ECw = Electrical Conductivity of Irrigation Water (dS/m)

ECe = Electrical Conductivity of Saturation Extract (dS/m)

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<tr>
<th></th>
<th>Alfalfa</th>
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IONIC SALT STRESS
