Nutrient Requirements for Tomorrow’s Genetic Innovations

Kristin Schneider, Ph.D.
Corn Technology
Monsanto Company
February 15, 2010
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RR = Roundup Ready; YGCB = YieldGard Corn Borer; RR2 = Roundup Ready Corn 2; YGVT = YieldGard VT; YGRW = YieldGard Rootworm; RR2Y = Roundup Ready 2 Yield; RRF = Roundup Ready Flex

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Monsanto Has Undergone Many Changes in the Past Decade, But the Technology Strategy Began Long Ago

<table>
<thead>
<tr>
<th>Decade</th>
<th>1980s</th>
<th>1990s</th>
<th>2000s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds</td>
<td>Monsanto Vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traits</td>
<td></td>
<td></td>
<td>Bayer CropScience Genuity</td>
</tr>
</tbody>
</table>

- Molecular Biology: Success modifying plants for Roundup®
- U.S. Gov. approves Roundup® for use with RR soybeans
- Approving Bollgard® cotton for modifying crops to resist insects
- Solvay spun off by Monsanto
- Merger with Pharmacia
- Initial public offering
Global Demand For Crops Projected to Grow Dramatically as Population/Income Continues to Rise

GROWING WORLD POPULATION (B)

GROWING WORLD POPULATION (B)  GROWING WORLD POPULATION (B)

GLOBAL GRAIN DEMAND (M MT)

Hundreds gather to protest global warming

http://climatechangefraud.com/humor/5943-hundreds-gather-to-protest-global-warming
Global Demand For Crops Projected to Grow Dramatically as Population/Income Continues to Rise

GROWING WORLD POPULATION (B)

<table>
<thead>
<tr>
<th>Year</th>
<th>Transition Nations</th>
<th>Developed Nations</th>
<th>Developing Nations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>1999</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>2030</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

GLOBAL GRAIN DEMAND (M MT)

- Rice: +102%
- Cotton: +125%
- Soybeans: +40%
- Wheat: +76%
- Corn: +28%

Global Trends Set Stage for Increasing Protein Demand Over the Next Decade

INCREASING PROTEIN DEMAND: Relationship Between GDP and Meat Consumption

**CONVERSION ESTIMATES**

<table>
<thead>
<tr>
<th>Item</th>
<th>Conversion to Grain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LB Beef</td>
<td>7-8 LBS GRAIN</td>
</tr>
<tr>
<td>1 LB Pork</td>
<td>2-3 LBS GRAIN</td>
</tr>
<tr>
<td>1 LB Chicken</td>
<td>1-2 LBS GRAIN</td>
</tr>
</tbody>
</table>

**FIRST $10K IN PER-CAPITA GDP:**
- Includes emerging economic powers like China and Brazil
- Has largest meat-consumption spread (82 kg/person) of any $10K increment - indicating opportunity for ascension with small increases in actual income

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2. FAOSTAT | © FAO Statistics Division 2007 | 30 October 2007
A Global Commitment To Growing Yield Sustainably®

THREE MAIN GOALS ARE AT THE HEART OF THIS EFFORT

- Help farmers **DOUBLE YIELDS** in corn, cotton & soybeans by 2030
- **REDUCE** by 1/3 the inputs required per unit of output
- **IMPROVE THE LIVES** of farmers around the world
What Does it Mean to Double Yield in the U.S. by 2030?

How Are We Going to Reach These Goals?

**Breeding**
Creates new, more robust varieties that perform better in the field.

**Biotechnology**
Adds special beneficial genes to the plant.

**Agronomics**
Agronomic practice improvements make acres more productive.

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**Corn**
- 2000 Baseline: 137 bu/ac
- 2030 Goal: 300 bu/ac

**Soybean**
- 2000 Baseline: 37 bu/ac
- 2030 Goal: 80 bu/ac

**Cotton**
- 2000 Baseline: 632 lbs/ac
- 2030 Goal: 1,300 lbs/ac
Corn Yield Components to 2030

U.S. corn yield has doubled in the last 40 years

153.9 bu/ac

U.S. corn yield has doubled in the last 40 years
Corn Yield Components to 2030

Historical trend brings yields to ~200 bu/ac by 2030
Additional gains from breeding, agronomic practice improvements and new biotechnology products bring yield potential to ~300 bu/ac by 2030.
Produce More, Conserve More®: Pesticide, Nitrogen, Rainfall Use Declining In Corn

Data Source: USDA, NASS “Agricultural Chemical Usage Report”; dmrkynetec; NOAA; USDA ERS
HELPING FARMERS MEET THE DEMAND: BREEDING
Plant Breeding is Experiencing a Technical Revolution That Will Drive Yield Improvements

Annually, breeders exchange more than a million different “packages” of germplasm material.

>50% of Monsanto’s corn hybrids result from intra-company crosses.

**Corn SEED GERMPLASM LIBRARY**
Is Our Building Block for Better Breeding

**MOLECULAR BREEDING** is Accelerating the Rate of Gain Over Conventional Breeding

- Capability to analyze 10s of millions of samples
- 3 million marker-trait associations providing detailed genome understanding

**Soybean Seed Chipper**
Automated Marker Analysis
Seed Chippers Simplify & Speed up the Breeding Process
Expansive Breeding and Testing Geography Enables Effective Product Identification and Placement

Monsanto U.S. Corn Breeding Testing Locations

Regional breeding teams:

- Focus on most elite germplasm
- Maintain important germplasm types
- Enhance product diversity
- Enhance breeder germplasm knowledge and info exchange
HELPING FARMERS MEET THE DEMAND: BIOTECHNOLOGY
Commercialization is dependent on many factors, including successful conclusion of the regulatory process.
We Address Challenges One Phase at a Time, Beginning with Discovery

<table>
<thead>
<tr>
<th>DISCOVERY Gene/Trait Identification</th>
<th>PHASE I Proof Of Concept</th>
<th>PHASE II Early Development</th>
<th>PHASE III Advanced Development</th>
<th>PHASE IV Pre-launch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AVERAGE DURATION</strong>&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>24 to 48 MONTHS</td>
<td>12 to 24 MONTHS</td>
<td>12 to 24 MONTHS</td>
<td>12 to 24 MONTHS</td>
<td>12 to 36 MONTHS</td>
</tr>
<tr>
<td><strong>SPENDING</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$2-5M</td>
<td>$5-10M</td>
<td>$10-15M</td>
<td>$15-30M</td>
<td>$20-40M</td>
</tr>
<tr>
<td><strong>AVERAGE PROBABILITY OF SUCCESS</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 PERCENT</td>
<td>25 PERCENT</td>
<td>50 PERCENT</td>
<td>75 PERCENT</td>
<td>90 PERCENT</td>
</tr>
</tbody>
</table>

**Monsanto Discovery & Collaborative Partners**

- **Genes in Testing**
  - TENS OF THOUSANDS
  - THOUSANDS
  - 10s
  - <5
  - 1

- **Key Activity**
  - HIGH-THROUGHPUT SCREENING
  - MODEL CROP TESTING
  - GENE OPTIMIZATION
  - CROP TRANSFORMATION
  - TRAIT DEVELOPMENT
  - PRE-REGULATORY DATA
  - LARGE-SCALE TRANSFORMATION
  - TRAIT INTEGRATION
  - FIELD TESTING
  - REGULATORY DATA GENERATION
  - REGULATORY SUBMISSION
  - SEED BULK-UP
  - PRE-MARKETING

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<sup>1</sup>Time estimates are based on our experience; they can overlap. Total development time for any particular product may be shorter or longer than the time estimated here.

<sup>2</sup>This is the estimated average probability that the traits will ultimately become commercial products, based on our experience. These probabilities may change over time.
Genuity™ SmartStax™ Corn Increases Yield Potential Through Better Weed and Insect Control

* Yield benefit reflects expected yield benefit above triple-stack standard, on a per-acre and whole-farm basis as noted. Ranges may overlap.

<table>
<thead>
<tr>
<th>Year</th>
<th>Discovery</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Launch</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>2003</td>
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<tr>
<td>2009</td>
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<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
# Genuity™ SmartStax™: The Best Spectrum

<table>
<thead>
<tr>
<th>PRIMARY PESTS</th>
<th>Optimum® AcreMax™ 1</th>
<th>Agrisure® 3000GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Corn Borer (Ostrinia nubilalis)</td>
<td>☑ ☑ ☑</td>
<td>☑</td>
</tr>
<tr>
<td>Southwestern Corn Borer (Diatraea grandiosella)</td>
<td>☑ ☑ ☑</td>
<td>☑ ☑</td>
</tr>
<tr>
<td>Northern Corn Rootworm (Diabrotica barberi)</td>
<td>☑ ☑ ☑</td>
<td>☑ ☑</td>
</tr>
<tr>
<td>Western Corn Rootworm (Diabrotica virgifera virgifera)</td>
<td>☑ ☑ ☑</td>
<td>☑ ☑</td>
</tr>
<tr>
<td>Corn Earworm (Helicoverpa zea)</td>
<td>☑ ☑</td>
<td></td>
</tr>
<tr>
<td>Fall Armyworm (Spodoptera frugiperda)</td>
<td>☑ ☑ ☑</td>
<td>☑</td>
</tr>
<tr>
<td>Western Bean Cutworm (Richia albicosta)</td>
<td>☑ ☑</td>
<td>☑</td>
</tr>
<tr>
<td>Black Cutworm (Agrotis ipsilon)</td>
<td>☑ ☑</td>
<td>☑</td>
</tr>
<tr>
<td>Herbicide Tolerance</td>
<td>☑ ☑ ☑</td>
<td>☑ ☑ ☑</td>
</tr>
<tr>
<td>Refuge (corn belt)</td>
<td>5% 20%</td>
<td>20% for Above Ground 20%</td>
</tr>
</tbody>
</table>

- ☑ Single mode activity
- ☑ ☑ Dual mode activity
- ☑ ☑ ☑ Triple mode activity

Herculex and Design are registered trademarks of Dow AgroSciences LLC. Optimum and AcreMax are trademarks of Pioneer Hi-Bred International, Inc. Agrisure is a registered trademark of Syngenta Participations AG.
Next Step: Refuge In a Bag

80% + 20% =

95% + 5% =

Blended in the Bag

Commercialization is dependent on many factors, including successful conclusion of the regulatory process.
Field Testing Showed Lead Drought Event Increased Yield in Stressed Conditions

DROUGHT TOLERANT CORN FAMILY

- Targeted to minimize uncertainty in farming by buffering against effects of water limitation
- In U.S., this historically has been dryland farms of Western Great Plains

DROUGHT TOLERANT CORN FAMILY

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Launch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discovery</td>
<td>Proof of Concept</td>
<td>Early Development</td>
<td>Adv. Development</td>
<td>Pre-Launch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
1st & 2nd Generation Drought Tolerant Corn Products Are Designed to Meet the Needs of Farmers in Different Regions

<table>
<thead>
<tr>
<th>Western US Dryland</th>
<th>Drought “Insurance”</th>
<th>Reduced Irrigation Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS, NE, TX, CO, SD, ND 10-13 M acres corn</td>
<td>Central, E. and S. Corn Belt 30-50M acres</td>
<td>KS, NE, TX, CO, ID 12M acres</td>
</tr>
</tbody>
</table>

- **Drought 1** Targets a Yield Advantage in Western Great Plains Dryland production
- **Drought 2** Adds a Yield Advantage in Drought “Insurance” Market When Drought Occurs
Lead Higher-Yielding Corn Events Show Improved Yield Across Multiple Years and Testers

With Gene Control

• Two years of consistent yield performance across multiple testers and events in high yielding hybrids

• Testing in 2010 will expand germplasm panel and trial types

Aimed at boosting the intrinsic yield potential of corn hybrids.
The future - Focus on work at Monsanto
Targets ways to Use Nitrogen More Efficiently in Corn

Nitrogen Facts
- Only 40-60% of Nitrogen applied to corn is taken up and used during the first year
- $391M of Nitrogen fertilizer is lost down the Mississippi River
- N₂O is ~290X more potent greenhouse gas than CO₂

Nitrogen Utilization Corn:
- Can potentially boost yield under normal nitrogen conditions or stabilize it in low nitrogen environments
- Can reduce agriculture’s overall impact on the environment

Sources: O’Neill et al., 2004; http://nue.okstate.edu/; Microbial Life Educational Resources; http://www.ewg.org/
Exploring Nitrogen Use Efficiency as an Indirect Benefit of YieldGard® Traits

Stacked Traits in Elite Germplasm Facilitate Greater Yields Through More Efficient Use of Nitrogen Resources

Figure 5. Comparison of grain yield to fertilizer N rate. University of Illinois Crop Physiology Lab. 2006.
Corn grain produced in the U.S. per unit of fertilizer N used, 1964 to 2005.

Since 1975: 51% increase in N efficiency 12% increase in N fertilizer use

Data sources: USDA Ag Chem Use Survey & Annual Crop Production.
Diverse Mechanisms for Nitrogen-Use Efficiency Leads

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Leads</th>
<th>Processes that Impact Nitrogen Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced Nitrogen Uptake/Transport</td>
<td>✓</td>
<td>Storage and Remobilization</td>
</tr>
<tr>
<td>Improved Nitrogen Assimilation</td>
<td>✓</td>
<td>C/N Balance</td>
</tr>
<tr>
<td>Enhanced Protein Synthesis</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Improved photosynthesis</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Improved General Stress Response</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pathway regulation</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

- Pathways that lead to enhanced nitrogen use include:
  - Enhanced Nitrogen Uptake/Transport
  - Improved Nitrogen Assimilation
  - Enhanced Protein Synthesis
  - Improved photosynthesis
  - Improved General Stress Response
  - Pathway regulation

- Processes that impact nitrogen use:
  - Storage and Remobilization
  - C/N Balance
  - Amino Acids
  - Proteins
  - Chlorophyll
  - Assimilation
  - Uptake
  - Sensing

- Nitrogen pathways:
  - NO₃⁻
  - NH₄⁺
Extensive Nitrogen Field Testing Network Developed; Several Promising Leads Identified for Advanced Testing

Jerseyville, IL - June 2009

2009 REDUCED-NITROGEN TRIAL RESULTS (60 LB N APPLIED)

Percent Yield Difference - Gene vs. Control

<table>
<thead>
<tr>
<th>Gene 1</th>
<th>Gene 2</th>
<th>Gene 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0%</td>
<td>6.2%</td>
<td>6.2%</td>
</tr>
</tbody>
</table>

Top-Performing Events
Average Gene Performance

Discovery Phase 1
Proof of Concept
Phase 2
Early Development
Phase 3
Adv. Development
Phase 4
Pre-Launch
Launch

Applied N (lb/acre)
Nitrogen “Calibration” Strip

Year
2008
2009

Gene 1
9 locations
Gene 2
9 locations
Gene 3
4 locations
Pipeline Biotech Soybean Projects

Commercialization is dependent on many factors, including successful conclusion of the regulatory process.
HELPING FARMERS MEET THE DEMAND: AGRONOMIC PRACTICES
Agronomic Practice Improvements Expected to Continue to Increase Yields in the U.S.

**BREEDING AND BIOTECH ARE CRITICAL, BUT SO ARE OTHER CONTRIBUTORS**

**AGRONOMIC PRACTICE**

<table>
<thead>
<tr>
<th>AGRONOMIC PRACTICE</th>
<th>BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungicides</td>
<td>Using Headline® fungicide in an acre of corn can bring a 10 to 13.5 Bu/A benefit to the grower.</td>
</tr>
<tr>
<td>Plant Populations</td>
<td>More strategic planting densities can increase bushels per acre, even with today’s traits and genetics.</td>
</tr>
<tr>
<td>Precision Agriculture</td>
<td>More precise use of every acre - from GPS-guided tractors to GIS to yield mapping - allows growers to maximize use of inputs and land to get the best return on investment.</td>
</tr>
<tr>
<td>Seed Treatments</td>
<td>New treatments to be commercialized with the launch of Genuity™ SmartStax™ should add an incremental yield benefit.</td>
</tr>
</tbody>
</table>

**IMPROVEMENTS IN AG PRACTICES HAVE ALREADY CONTRIBUTED ABOUT 40% TO YIELD GAINS**

Headline is a registered trademark of BASF Corporation.
Interaction of Hybrid, Row Spacing & Populations

Corn Yield (bushels per acre)

Plant Population (plants per acre)

Hybrid A

Hybrid B

Hybrid C

Atlantic, IA, and Rochelle, IL locations, 2009.

Single Row

Twin Row

Plant Population (plants per acre)
Reinventing Seed Treatment Products to Deliver Breakthrough in Performance

Partnering To Find Solutions

Monsanto was Largest Seed Treatment Customer in the Industry

PAST TO TODAY

Monsanto treated over 1,000,000,000 pounds of seed in 2007

Roundup Ready 2 Yield soybeans with Acceleron

Leading competitor's Roundup Ready soybeans with CruiserMaxx

Untreated Roundup Ready soybeans

Soybean Seed Treatment Vigor Comparison – Nebraska 2009 Field Trials

Nematodes
Root Worm
Wire Worms
Seed Maggot
Disease Control

Polymers
Encapsulation
Nutrients
Intrinsic Yield
Stress

Backed by the industry's largest, most rigorous testing program
Agricultural Management Practices Can Help Make the Most of Available Soil Moisture

Eight years of research in the Western Great Plains demonstrates that strip tillage:

- Improves soil quality (organic matter, # worms, water uptake rate, # soil pores)
- Improves fertilizer utilization
- Increases roots by 33–44%
- Yields equal or better than conventional tillage

Source: Mike Petersen, Precision Tillage Specialist, Orthman Manufacturing
DOUBLING YIELDS BY 2030 WILL REQUIRE COLLABORATION

• Farmers will double yields by 2030 and we will play our part along with others in the agriculture industry to help make 300 bushel corn a reality in 2030.

WE ALL HAVE A ROLE AND RESPONSIBILITY TO HELP ADDRESS GLOBAL AGRICULTURAL ISSUES

• New technologies play an integral part in ensuring global food and energy security in the face of challenges like population, water and land limits.

• Together, we can support increasing agricultural productivity in a sustainable way.