Agenda

• Customers and Consumers
  − Global Demand for Crop Productivity
  − Utilization

• Product Development
  − Production Trends and Desired Traits
  − Maize and Soybean

• Opportunities
  − Molecular Breeding
  − Traits – Transgenic & Native
Customers and Consumers

Global Demand for Maize – World Grain Production

Since 1980: Global Maize Acres +4.8%
Global Maize Production +45% or 130 million “virtual” acres!

Source: USDA, FAO, Global Insight; Resulting analysis: Pioneer Marketing Department
Customers and Consumers

Global Demand Measures Over the Last Decade

Source: USDA, FAO, Global Insight; Resulting analysis: Pioneer Marketing Department
Growth in Ethanol Is Driving U.S. Maize Utilization

Maize Utilization

Million bushels

Feed  Fuel Alcohol  Exports
Projected Ethanol Production Growth

% of maize production utilized if crop size stayed at 2006/2007 levels

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Source: PRX 8.1.06
Projected U.S. Maize & Soy Acreage Changes...the Biofuels Effect
# Plant Breeding

## Production Trends and Desired Traits

<table>
<thead>
<tr>
<th>Production Trends – Risk/Reward</th>
<th>Desired Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduced tillage systems</td>
<td>• Stand establishment</td>
</tr>
<tr>
<td>• Monoculture</td>
<td>– Weed control</td>
</tr>
<tr>
<td>• Earlier planting times</td>
<td>– Nutrient utilization</td>
</tr>
<tr>
<td>• More uniform plant to plant spacing</td>
<td>– Cold tolerance</td>
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<tr>
<td></td>
<td>– Disease and insect resistance</td>
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<tr>
<td></td>
<td>– Seed quality</td>
</tr>
<tr>
<td>• Increased rate of vegetative growth</td>
<td>• Vegetative growth</td>
</tr>
<tr>
<td>• Obtain healthier plants throughout the growing season</td>
<td>– Root and stalk strength</td>
</tr>
<tr>
<td>• Reduced use of fertilizers, insecticides, fungicides and herbicides</td>
<td>– Disease and insect resistance</td>
</tr>
<tr>
<td></td>
<td>– Drought tolerance</td>
</tr>
<tr>
<td></td>
<td>– Nutrient utilization</td>
</tr>
<tr>
<td>• Reduced harvest losses</td>
<td>• Reproduction and grain fill</td>
</tr>
<tr>
<td>• Decreased time and fuel consumption</td>
<td>– Drought tolerance</td>
</tr>
<tr>
<td>• Yield monitoring at harvest</td>
<td>– Grain composition</td>
</tr>
<tr>
<td></td>
<td>– Dry down</td>
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<tr>
<td></td>
<td>– Yield</td>
</tr>
<tr>
<td></td>
<td>– Stalk strength</td>
</tr>
<tr>
<td></td>
<td>– Nutrient utilization</td>
</tr>
<tr>
<td>• Improved nutritional value for food and feed uses</td>
<td>• Food, Feed, Industry</td>
</tr>
<tr>
<td>• Improved characteristics for industrial use</td>
<td>– Balanced Amino Acids</td>
</tr>
<tr>
<td></td>
<td>– Improved oil quality</td>
</tr>
<tr>
<td></td>
<td>– Increase content of energy, protein, oils, vitamins and decreased fiber</td>
</tr>
</tbody>
</table>
21st Century Product Development

Molecular Breeding
Association Mapping, Extensive Cross-referenced Genetics libraries

Trait Enhancement
Creating new levels of trait variation through native gene and transgene opportunities

Phenotypic Evaluation
Intimate knowledge of traits and ability to develop high throughput assays

Biological Information
Math, Statistics, Modeling, Breeding, and Bioinformatics

Increased Rate of Genetic Gain for Desired Traits
Yield Improvements for Maize and Soybeans (U.S.)

**Maize**

- **Open Pollinated**
- **Single Cross Hybrids**
- **Double Cross Hybrids**

**Soybeans**

- **USA Trend:** \( y = 0.412x - 785 \)  \( R^2 = 0.678 \)

**Genetic Gain**
# Pioneer Hi-Bred International, Inc. - Trait Pipeline View

## Target Markets

<table>
<thead>
<tr>
<th>Discovery</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gene/Trait Identification</td>
<td>Proof of Concept</td>
<td>Early Development</td>
<td>Advanced Development</td>
<td>Pre-Launch</td>
</tr>
</tbody>
</table>

### Corn
- Anthracnose Stalk Rot Resistance
- Fungal Disease Resistance
- Optimum™ GAT™
- Corn Rootworm Resistance II
- Corn Rootworm Resistance III
- Corn Borer Resistance II
- Corn Borer Resistance III
- Drought Tolerance
- Nitrogen Use Efficiency
- Increased Yield I
- Increased Yield II
- Increased Ethanol Production II
- Increased Ethanol Production III
- Improved Feed II
- Improved Feed III
- Seed Production Technology

### Soybeans
- Asian Soybean Rust Resistance
- Optimum™ GAT™
- Glyphosate ALS Tolerance II
- Insect Resistance
- Cyst Nematode Resistance
- Increased Yield I
- Increased Yield II
- Improved Feed I
- Improved Feed II
- High Oleic + High Stearic Acid Oil
- High Oleic Acid Oil
- Omega-3 Oil
- Improved Flavor
- Improved Functionality

### Other Crops
- Glyphosate Tolerant Cotton
- GlyphosateALS Tolerant Cotton
- Insect Resistant Cotton
- Nematode Resistant Cotton
- Insect Resistant Rice
- Glyphosate Tolerant Canola

*Proprietary Pioneer GlyphosateALS Tolerant trait*
Insect Protection

2\textsuperscript{nd} and 3\textsuperscript{rd} generation traits

- Expanded insect control and modes of action
- Flexible combinations with herbicides and insecticide seed treatments
- Convenient, safe and easy to handle

Herculex Insect Protection technology by Dow AgroSciences and Pioneer Hi-Bred.

\(\text{E} = \text{Excellent}\)
\(\text{VG} = \text{Very Good}\)
\(\text{G} = \text{Good}\)

<table>
<thead>
<tr>
<th>Insects</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Corn Borer</td>
<td>E</td>
</tr>
<tr>
<td>Southwestern Corn Borer</td>
<td>E</td>
</tr>
<tr>
<td>Fall Armyworm</td>
<td>E</td>
</tr>
<tr>
<td>Black Cutworm</td>
<td>VG</td>
</tr>
<tr>
<td>Western Bean Cutworm</td>
<td>VG</td>
</tr>
<tr>
<td>Corn Ear Worm</td>
<td>G</td>
</tr>
<tr>
<td>Western Corn Rootworm</td>
<td>E</td>
</tr>
<tr>
<td>Northern Corn Rootworm</td>
<td>VG</td>
</tr>
<tr>
<td>Mexican Corn Rootworm</td>
<td>E</td>
</tr>
</tbody>
</table>

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Herbicide Resistance

2\textsuperscript{nd} & 3\textsuperscript{rd} generation weed control options

- Improve and increase weed management
- Provide options for multiple crop rotation scenario’s
- Incorporate multiple modes-of-plant protection
- **Nitrogen Responsiveness**
  - Average nitrogen cost = $56/acre
  - Environmental impact

- **Objectives**
  - Maintain yield using less nitrogen
  - Increase yield at current nitrogen levels

- **Testing and evaluation environments critical**
Soybean Cyst Nematode

- Resistance widely integrated through pedigree-based breeding
- Opportunity for marker use identified more than 10 years ago
- SCN races – Going forward will be dealt with effective use of markers and transgenes
Asian Soybean Rust Resistance

• Devastating windborne fungal disease
• Trait technology solutions are in discovery phase
  – Numerous leads identified
Drought Tolerance

• Primary limiting factor in U.S. soils
• Transient water deficits are common in the Corn Belt
• One in five years water is a significant limitation to yield
• Estimated annual US drought losses $3 billion
  • Globally $8B annually
Modern Hybrids Are More Drought Tolerant

• **Product Goal**
  - Commercial hybrids with top end yield potential, protected by drought tolerance

• **Approaches**
  - Conventional breeding
  - Molecular breeding
  - Transgenic

Productivity Improvements of Pioneer® Brand hybrids under Drought Stress

- Productivity improvements over decades of release:
  - 20's: 2 Bushels per inch of water
  - 30's: 3 Bushels per inch of water
  - 40's: 4 Bushels per inch of water
  - 50's: 5 Bushels per inch of water
  - 60's: 6 Bushels per inch of water
  - 70's: 7 Bushels per inch of water
  - 80's: 8 Bushels per inch of water
  - 90's: 9 Bushels per inch of water

Decade of Release
Key to Success

Selection Environment – Managed Field Conditions
Differential Water Stress

Full Irrigation  Mild Stress  Moderate Stress
Differential Water Stress

- Plant Height
- Ear Size
- Kernel Number
Anthracnose Stalk Rot Resistance

- Anthracnose Stalk Rot Resistance
  - Most common stalk rot worldwide
  - Causes significant yield losses
  - Disease incidence expected to increase
    - No-till & reduced tillage practices
    - More continuous corn

Susceptible hybrid without trait
Resistant hybrid with trait
Anthracnose Stalk Rot Resistance

With Trait

Without Trait
Soy of the Future

For Food
- Better flavor
- Better protein quality
- Better digestibility
- Healthier oils
  - Low linolenic
  - High oleic
  - Omega-3

For Feed
- Higher available energy
- Higher protein level
- Better protein quality
- Better digestibility

*In high yielding genetic background with productivity traits*
Maize of the Future

For Feed
- Higher available energy
- Higher protein level
- Better protein quality
- Better digestibility
- Better meat quality

For Dry Grind Ethanol
- Higher total fermentables
- Enhanced ethanol yield
- Improved distiller’s grain quality

In high yielding genetic background with productivity traits
The industry has begun to characterize seed products for suitability for specific markets.

Pioneer IndustrySelect™ hybrids and varieties are targeted for end use markets:

- **White and yellow food corn**
- **Wet milling industry**
  - Extractable starch (HES)
  - Waxy corn
- **Dry grind ethanol industry**
  - High Ethanol Hybrids (HTF)
- **Swine and poultry industries**
  - Available energy (HAE)
- **Soybeans**
  - High Protein / Oil
  - Low Linolenic
- **Canola**
  - High Oil
Not all seed products are the same for ethanol yield

- Pioneer hybrids have about 7% variation in ethanol yield.
- Yield and agronomics are critical in maximizing ethanol yield per acre in addition to HTF classification.

Other Factors to consider:
- Changes in processing technologies
- Crop environment, farming practices
Biofuels and the Acre

- 1 acre of corn (160 bu) = 439 gallons
- 1 acre of corn stover (50% removal) = 155 gallons of ethanol
- 1 acre of sugar beets (23 tons) = 552 gallons of ethanol
- 1 acre of Brazil sugar cane = 600 gallons of ethanol
- 1 acre of soybeans (43 bu) = 60 gallons of biodiesel
- 1 acre of canola (1557#) = 77 gallons of bio-diesel
Cellulosic Feedstocks for Ethanol

A View of the Future

Moving beyond corn grain

12 Billion Bu of corn would produce ~34 Billion gallons of ethanol
The Challenge

• Global Population
  – 2000 = 6 billion
  – 2050 = 9 billion (With 98% of growth coming from developing countries)

• Malnutrition/Poverty
  – 840 million in chronic malnutrition, many more have ‘hidden hunger’
  – 1.3 billion afflicted by poverty

• Cultivatable Land per Capita
  – 0.45 hectares 1966
  – 0.25 hectares 1998
  – 0.15 hectares 2050

• World Grain Yield and Demand
  – Grew at 2.1% in 1980s, but less than 1% per annum in 1990s
  – Meat consumption tripled in last 40 years with mass urbanization and economic growth
  – More money equals more protein in the diet
  – Rapid growth of the biofuels industry
  – Balancing competing needs for corn grain supplies (feed, fuels)

Must double food production sustainably on same land area, by 2050
## Improved Input Traits

### Insect Resistance

<table>
<thead>
<tr>
<th>Competitor Trait</th>
<th>Herculex® I Black Cutworm Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poweshiek County, IA - 2006</td>
<td></td>
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</tbody>
</table>

### Herbicide Resistance

<table>
<thead>
<tr>
<th>Without Trait</th>
<th>With Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum™ GAT ™</td>
<td></td>
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</table>

### Nitrogen Responsiveness

Field Showing Nitrogen Deficiency
Improved Agronomic Traits

Disease Resistance

Asian Soybean Rust

With Trait

Without Trait

Drought Tolerance

Drought Tolerance

Check Hybrid

Experimental Hybrid

Disease Resistance

Anthracnose Stalk Rot

Without trait

With trait
Improved Output Traits

**Healthier Oils**

**Feed**

**Fuels**
Thank You