Application of Biotechnology to Traditional Crops for Biofuels

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Current biofuel solutions are challenged to meet global needs

DuPont Biofuel Opportunity Initiatives

Seed & Crop Protection Solutions

Ag Inputs
Seed & Crop Protection

Biobutanol, advanced biofuels

Advanced Fuels
Butanol

Cellulosic Fuels

Biofuels From Biomass
Corn: Bright Future as a Biofuels Feedstock

Long-Term Goal: 1,000 Gallons Per Acre of Corn

- More efficient conversion technologies
- Higher crop yields per acre
- More diverse feedstocks beyond grain

Ethanol Productivity

- Endosperm: 500 gallon/acre (2010)
- Pericarp: 18 gallon/acre (2010)
- Stover: 100 gallon/acre (2010)

Corn will be competitive with other feedstocks
The Challenge: Increasing Crop Productivity

Global Demand for Corn and Soy is Growing

North / South America have 14% of global population and 26% of arable land

Source: DuPont Worldwide Agriculture Forecast
Meeting the Increased Productivity Challenge

- Yield Per Acre Increases
- Molecular Markers
- Doubled Haploids
- Herbicide Traits
- Insect Traits
- Drought Tolerance
- Nitrogen Utilization
- Output Traits

Today

- Enabling Technologies
- Molecular Markers
- Doubled Haploids

2020
Molecular Markers: More Efficient Corn Breeding

- Phenotype = Genotype + Environment + GxE
- Markers allow for selection of genomic sections (QTL) with known phenotypic effects in environments where the trait is not expressed
- Starting point of finding the underlying genes responsible for phenotype
Doubled Haploids: Faster Corn Breeding

- **Advantages:**
  - Increases precision of molecular markers
  - Reduces hybrid development cycle time 1-2 years
  - Increases options for per se selection (parent traits, disease, maturity)
  - Breeding impact – more complex pedigree selection away from home nursery
Herbicide and Insect Control Traits

- Herculex® insect protection provides the most efficacious, sustainable insect control solution today
- In 2010, we will introduce stacks of a dual mode of action lepidopteran control traits coupled with HXRW
- Refuge reduction strategies being executed
- On track for a 2010 commercial introduction in corn
- Triple-mode herbicide tolerance when stacked with Herculex®
  - Glyphosate, ALS, Liberty
  - Maximum grower flexibility
- New ALS herbicide mixtures with multiple modes of action

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Critical Agronomic Traits

- **Drought Tolerance**
  - Four most advanced drought leads showing 5-14% yield increase in all stress locations (8) in the corn belt
    - No negative yield impact watered situation
    - All different modes of action
  - 50 new drought leads in phase one evaluation

- **Nitrogen Use Efficiency**
  - Greater than 20 NUE leads under evaluation in phase one
  - Top seven leads showing 10-25% yield increase in reduced nitrogen environments

Outstanding Performance in 2007 Field Trials
Pioneer’s Pipeline of Grain Traits For Fuel and Feed

- Increased functionality through optimization of genetic variation
- Increased total starch
- Improved fermentation properties
- Additional starch
- Additional oil
- Improved oil
- Improved digestibility
- Further increases in starch and oil
- Improved oil
- Digestibility
- Improved protein quality

- Increase ethanol yield
- Increase feed energy value
- Maximize DDG co-product protein quality
- Reduce unwanted or low-value kernel components
- Accommodate new processing technologies such as fractionation

High Grain Yields, Strong Agronomics and Input Traits are Key
Corn Remains Critical for Biofuels

- Crop yields need to increase to keep pace with demand
  - Since 1980
    - Global corn area increased 11%
    - Production increased 68%
- Future production increases driven by management, technology, & genetics
  - Enabling technologies
  - Insect and herbicide traits
  - Agronomic traits
  - Output traits

![World Corn Production: 1980-2016](chart)
Thank You
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or visit:

www.pioneer.com

www2.dupont.com/Biotechnology/en_US/