Fraunhofer

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Inaugural Fraunhofer – Delaware Technology Summit

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Energy and Life Sciences – Solutions for Sustainability

University of Delaware
Clayton Hall
March 5/6, 2013

Fraunhofer

UNIVERSITY OF DELAWARE

Inaugural Fraunhofer – Delaware Technology Summit

LIFE SCIENCES SOLUTIONS

Keynote Presentation

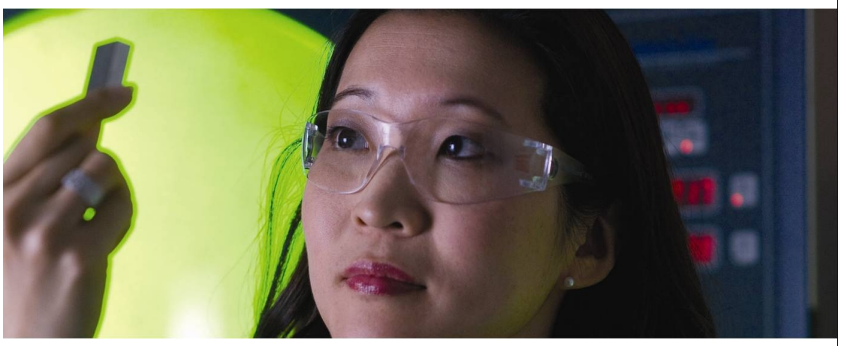
"Life Sciences Addressing Global Challenges"

– Douglas Muzyka
Senior Vice President and
Chief Science & Technology Officer
DuPont

Life Sciences Addressing Global Challenges

Douglas Muzyka, PhD
Senior Vice President and Chief Science & Technology Officer, DuPont

Key messages



- Science can address global challenges
- Integration of scientific disciplines is more powerful than any one alone
- Collaboration is key to delivering solutions

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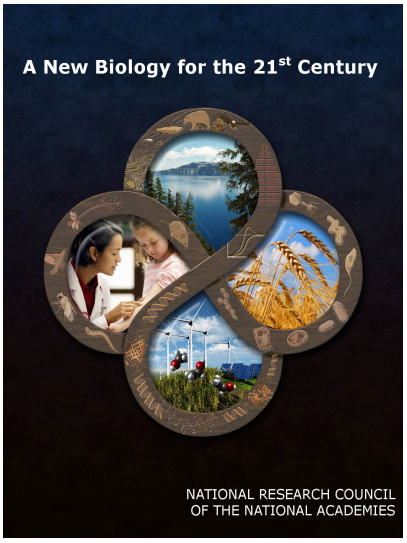
Agenda for Life Sciences: Global Challenges



National Academies propose "New Biology" initiative (2009)

- Biological Sciences at inflection point in their capacity to solve problems
- Opportunity to propel science to a new level
- Goal is to address significant societal needs

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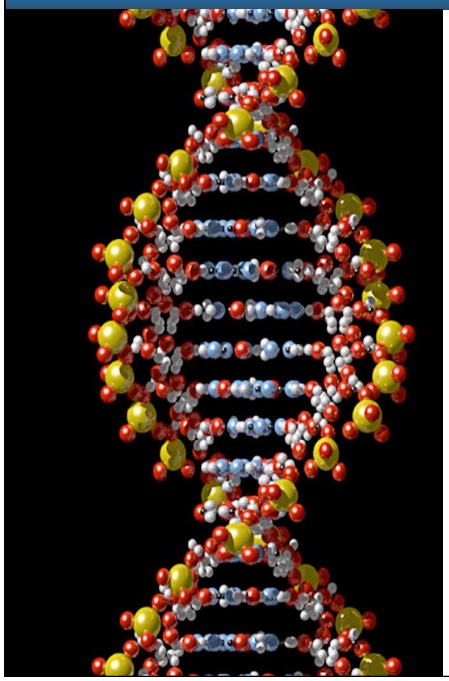

Biology at Inflection Point

- Increasingly integrating the sub-disciplines of biology
- Integrating with other disciplines: physical, computational, earth scientists, engineers
- Technological advances enables unprecedented data collection: quantity and quality
- Past investments providing value beyond expected

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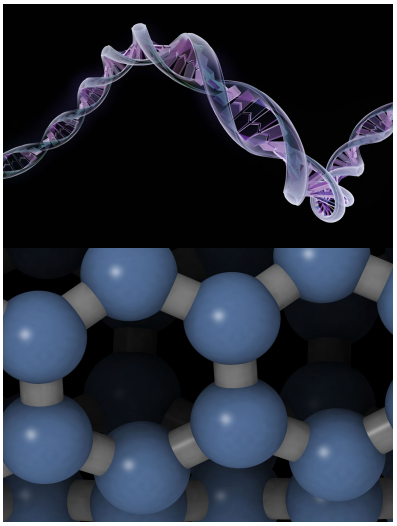
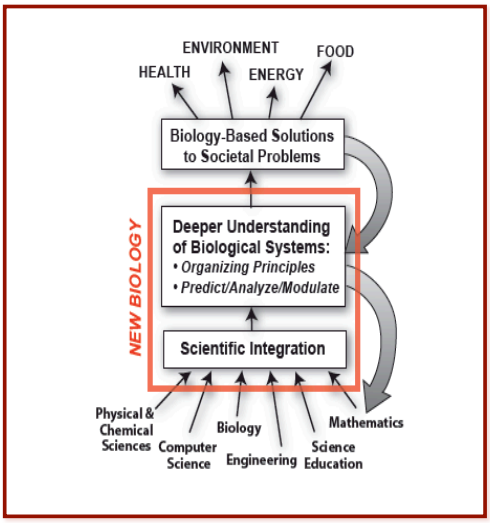
New Biology: Integration of Disciplines





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New Biology Initiative

Recommendations

Launch New Biology Initiative to:

- Accelerate the emergence and growth of the New Biology
- Achieve solutions to societal challenges in food, energy, environment, and health

Initiative should be:

- Interagency
- Ten years minimum duration
- Funded in addition to base missions

Develop the information sciences and technologies that will be critical to the success of the New Biology

Develop interdisciplinary curricula, graduate training and educator training needed to create and support New Biologists

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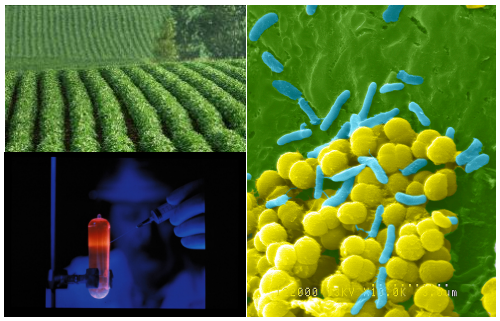
The National New Biology Initiative

Setting big goals: Address societal problems

- Food
- Environment
- Energy
- Health



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DuPont applies science to develop solutions for these major challenges

FEEDING THE WORLD	REDUCING OUR DEPENDENCE ON FOSSIL FUELS	KEEPING PEOPLE AND THE ENVIRONMENT SAFE

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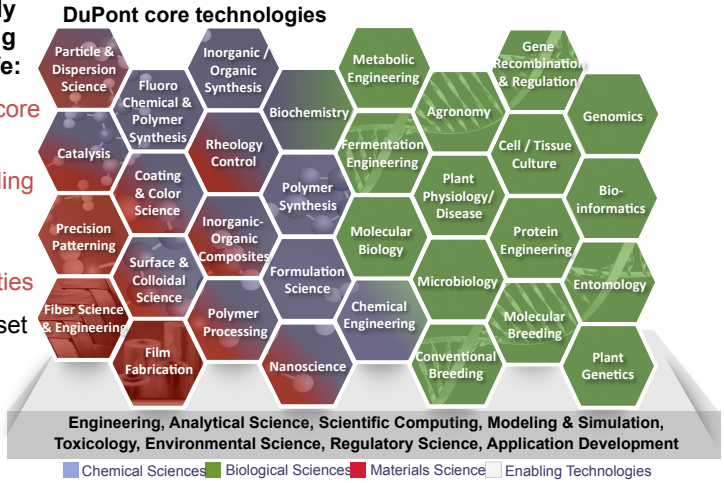
Integrated Science is our approach

DuPont is uniquely positioned to bring New Biology to life:

- Critical mass of core technology
- Leveraged enabling competencies
- Complementary external capabilities
- Integration mindset

DuPont core technologies



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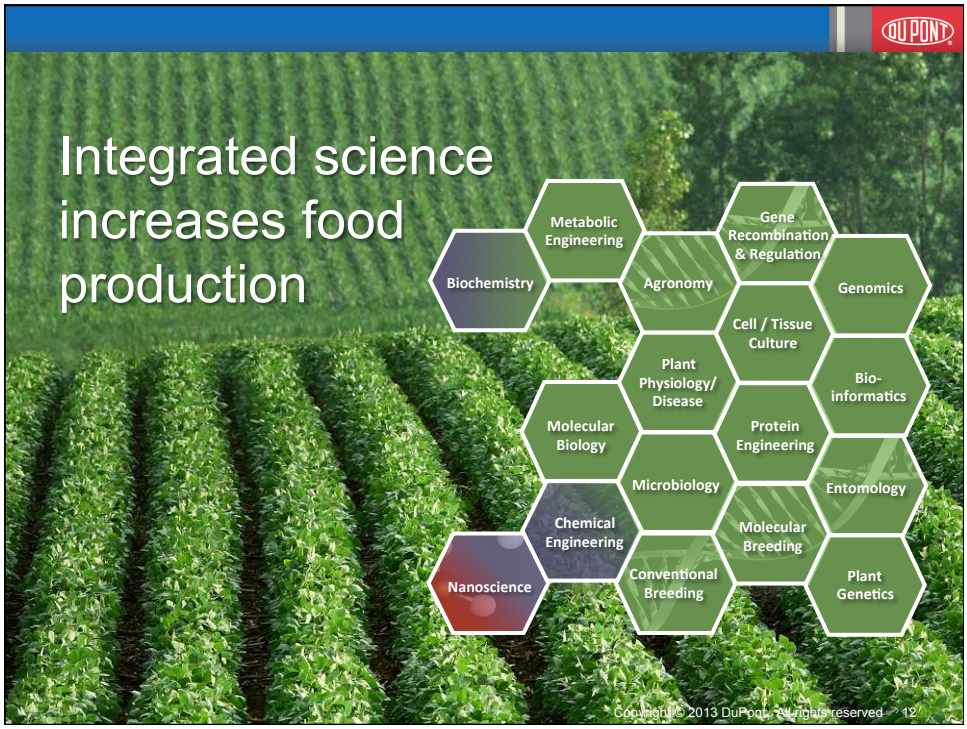

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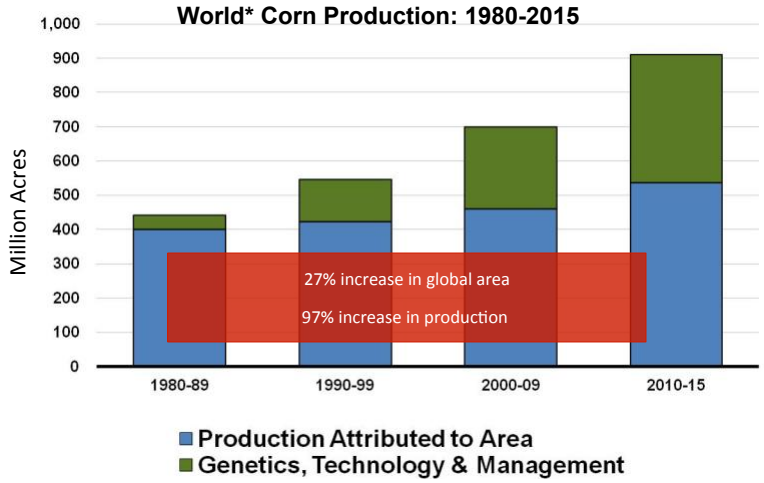
Science is at the core of increased productivity

Increased productivity created the equivalent of 275 million "virtual acres" in last 30 years



**Selected World Source: USDA, FAO, Global Insight; Resulting analysis: Pioneer Marketing Department*

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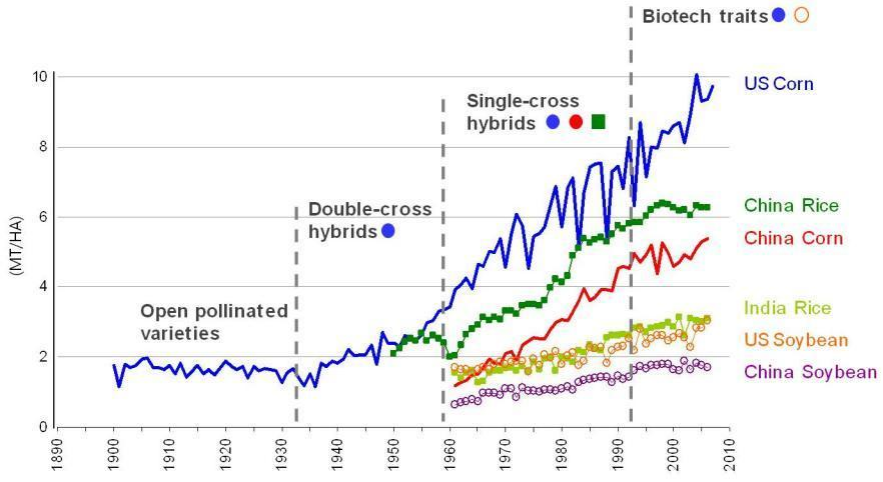
Integrated Science has Driven Yield Improvements

Breeding and Biotechnology Have Increased Yield



Source : USDA, IRRI and FAO

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Drought-Tolerant Corn:
Integrated Science to Protect Yields

Conventional | **Optimum® AQUAmax™ *Drought-tolerant***

Normal Water | Drought

Normal Water | Drought

Drought

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Nitrogen Use Efficiency (NUE)
Integrated Science to Improve the Sustainability of Agriculture

Normal Nitrogen

Nitrogen Stress

Increase in kernels per ear under nitrogen stress

Without Transgene | With Transgene

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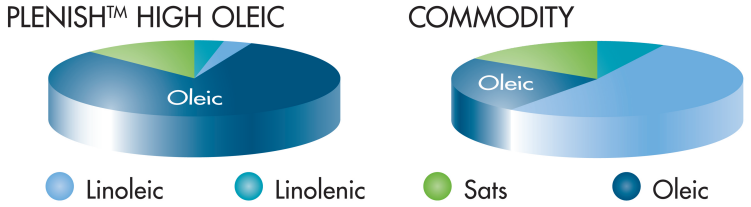
Plenish™ High Oleic Soybeans

- Biotech soybean with **consumer** benefits
- Enhanced functionality for food preparation
- Industrial application benefits
- High-yielding Pioneer® brand Y series varieties



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Integrated science unlocks the potential of advanced biofuels

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Low Carbon, Scalable, Sustainable

Cellulosic Ethanol: Non-food Feedstocks

Advantages:

- >60% greenhouse gas reduction
- Non-food sources and marginal land
- Multiple feedstock available
- Excellent income for farmers

Biobutanol: Better Fuel

Advantages:

- Drop-in fuel
- High blends without infrastructure changes
- Refinery can use more fractions of oil
- Higher energy content

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DuPont Cellulosic Ethanol Conversion Process

Feedstock	Milling & Pretreatment	Saccharification	Fermentation	Separation
• Large-scale test harvest • Commercial equipment • Agronomic understanding • Multi-year grower involvement	• Minimal capital • Facilitate enzymes • Minimize inhibitors • Mild process	• High solids • High sugar yield • High sugar titers • Low enzyme loading • Minimize inhibitors	• C5/C6 utilization • High ethanol yield • High ethanol titer	• Recover product • Recover lignin • Recycle water

Integrated Science and Collaboration are Key to Delivering Solutions

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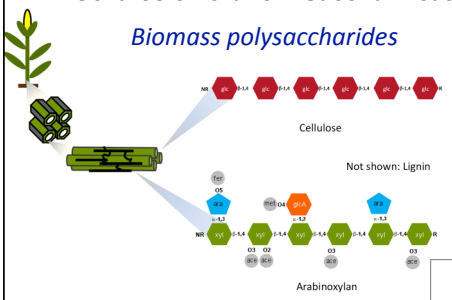
Integrated Science Creates Solutions

Cellulosic Ethanol: Saccharification Challenge

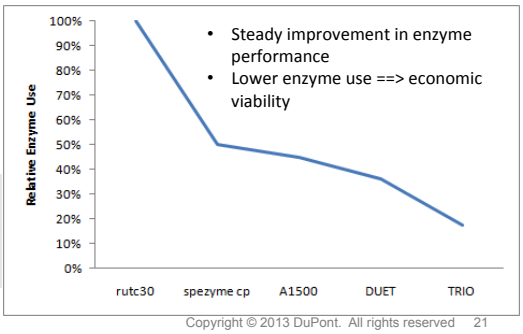
Biomass polysaccharides



Enzyme Discovery
Protein Engineering

- Complex structure
- Requires at least 6-8 enzyme activities, each optimized for for activity and stability

- **Protein production**
- **Specific activity**
- **Specific performance**
- **Inhibition**
- **Stability**



- Steady improvement in enzyme performance
- Lower enzyme use ==> economic viability

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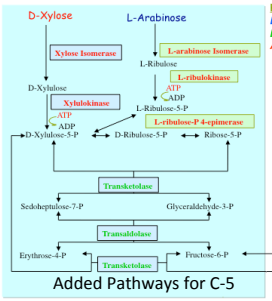
Integrated Science Creates Solutions

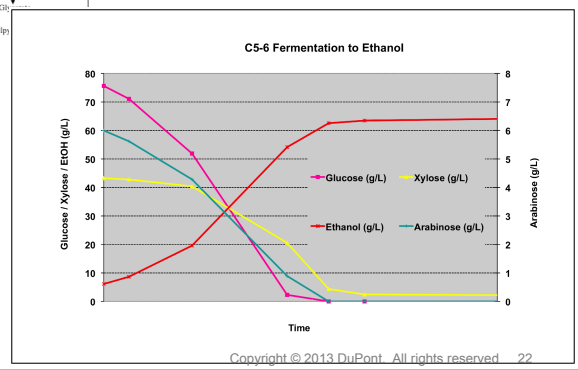
Cellulosic Ethanol: Fermentation Challenge



Added Pathways for C-5

Demonstrating performance at 80,000L scale

- Utilization of both 5 and 6 carbon sugars is essential
- Multiple pathways added in *Z. mobilis* to effect the C-5 conversion



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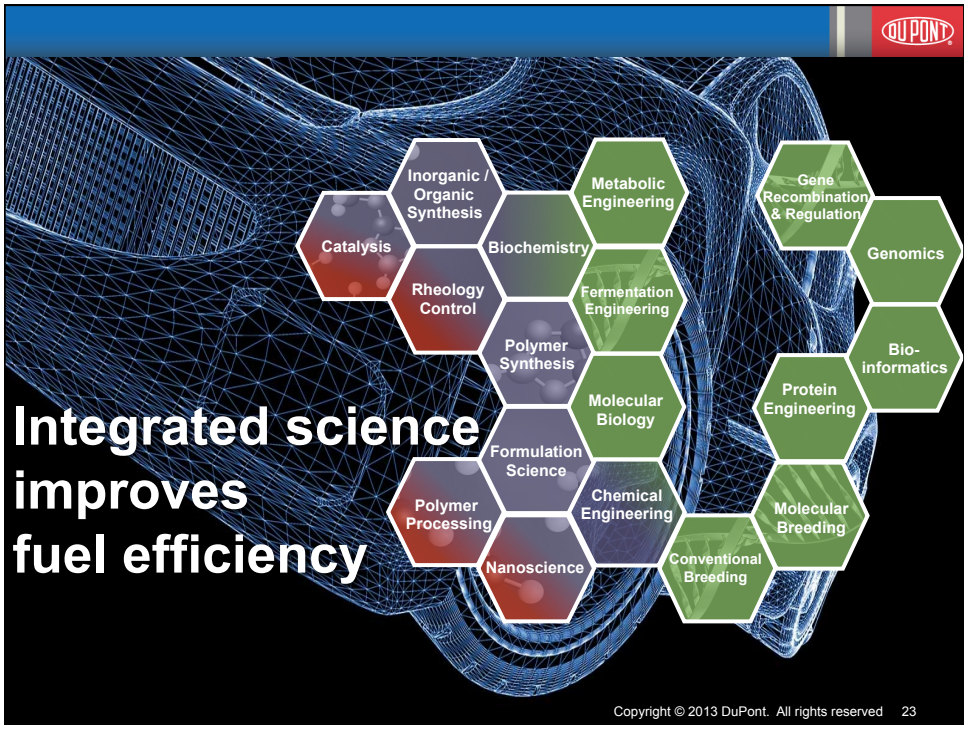
Integrated science improves fuel efficiency
Inorganic / Organic Synthesis
Metabolic Engineering
Gene Recombination & Regulation
Catalysis
Biochemistry
Genomics
Rheology Control
Fermentation Engineering
Polymer Synthesis
Bio-informatics
Molecular Biology
Protein Engineering
Formulation Science
Polymer Processing
Chemical Engineering
Molecular Breeding
Nanoscience
Conventional Breeding
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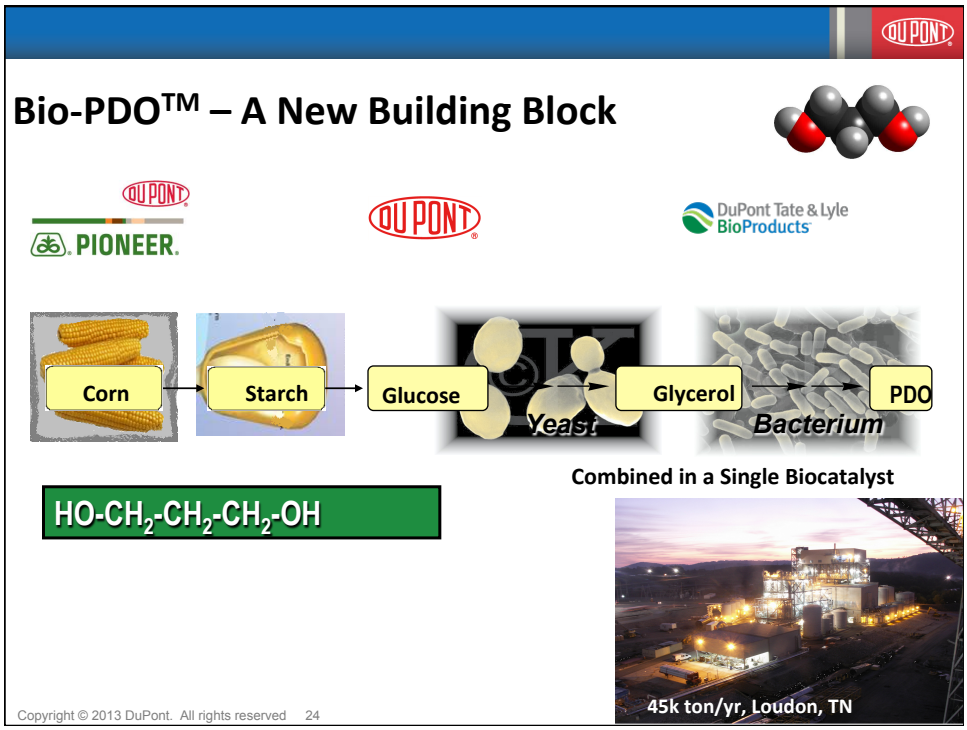
Bio-PDO™ – A New Building Block
PIONEER
DuPont Tate & Lyle BioProducts
Corn
Starch
Glucose
Yeast
Glycerol
Bacterium
PDO
Combined in a Single Biocatalyst
HO-CH2-CH2-CH2-OH
45k ton/yr, Loudon, TN
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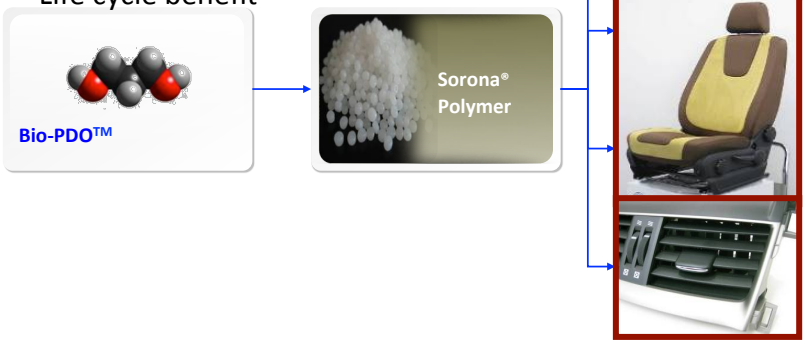
Sorona® Polymer – Sustainable, High Performance

- Unique product attributes driving adoptions
- Advantaged cost of manufacture & low capital intensity
- Life cycle benefit



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21st Century Innovation

Partnerships with Global Corporations, National Labs, Universities and Entrepreneurs

Inclusive Innovation

DuPont Technology

Market Knowledge

Customers

Integrated Solutions

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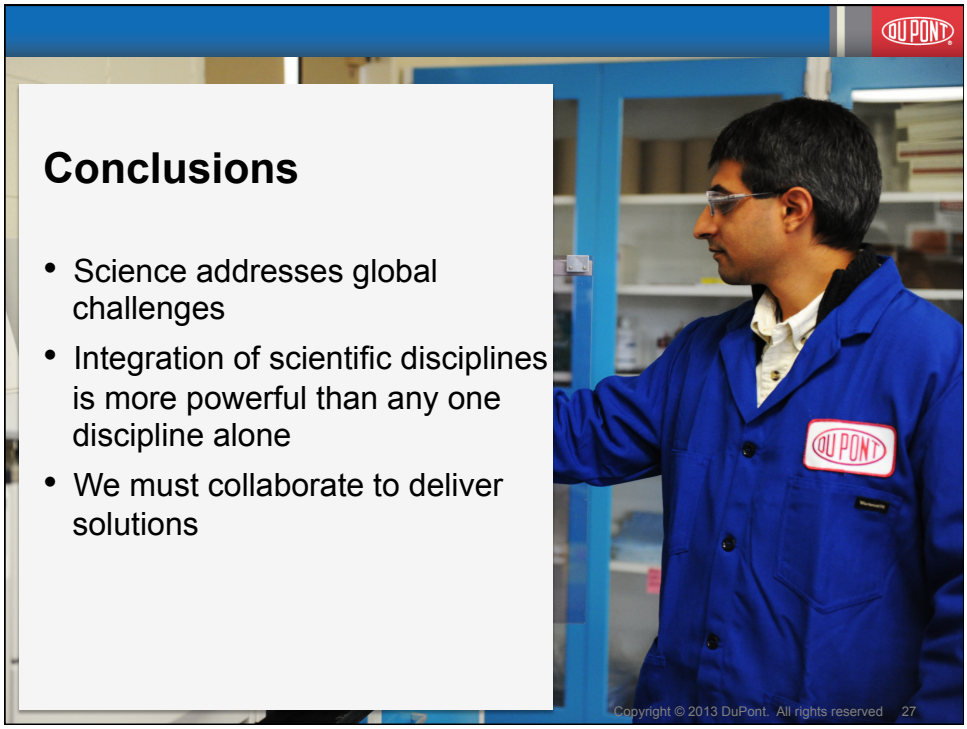
Conclusions
• Science addresses global challenges
• Integration of scientific disciplines is more powerful than any one discipline alone
• We must collaborate to deliver solutions
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