Monsanto and BASF Yield-and-Stress Collaboration Field Tour

Monmouth Research Facility, August 8, 2011

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Monsanto and BASF Yield-and-Stress Collaboration Field Tour Introduction

Monmouth Research Facility, August 8, 2011

Dr. Bob Reiter
Biotechnology Lead, Monsanto

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Scorecard of Key Metrics Reveals Progress and Power of Collaborative Efforts

YEAR FOUR – COLLABORATION STATUS UPDATE		
CATEGORY	**RELEVANCE**	**STATUS**
Genes Nominated	Increase in number improves probability of developing new products.	►More than 95% of gene nominations are unique
Transformed Events	Once gene is nominated, construct created and transformed events generated. Additional measure of probability of success.	►~30% increase in yield and stress transformations since start of collaboration
Gene/Events Evaluated	Events are evaluated via phenotypic and metabolic screens. Additional data points improve decisions for phase changes and stacking decisions, improving speed to market.	►>120 million metabolic data points (cumulative since April 2007) gathered on yield-and-stress events
Field Trials	Field trials indicative of robustness of program and advancement of leads resulting in new products.	►More than 72 permits or notifications filed for collaboration field trials in 272 locations across 29 states in the U.S. in 2011

Five Projects on Today's Tour to Highlight the Collaboration Work Across Corn and Soybean Crops

Tours Stops	*Presenters*
Soybean Yield-and-Stress Pipeline	
Higher-Yielding Soybean Family	Marie Petracek
BASF Chemistry	
Dicamba Formulation	Alyson Emanuel
Corn Yield-and-Stress Pipeline	
Drought-Tolerant Corn Family	Dusty Post
Higher-Yielding Corn Family	Tom Ruff
Nitrogen-Utilization Corn Family	Janice Edwards
Advances in Agriculture	
Biological Bar Graph	Troy Coziahr

Following the tour, dinner will be hosted by the BASF and Monsanto Management Teams

Monsanto and BASF Yield-and-Stress Collaboration Field Tour
Agronomy Center Overview
Monmouth Research Facility, August 8, 2011

Troy Coziahr
Learning Center Manager

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Field Testing at the Learning Center Produces Data to Inform Which Events to Advance in the Pipeline

Monmouth Agronomy Center

Research Facility

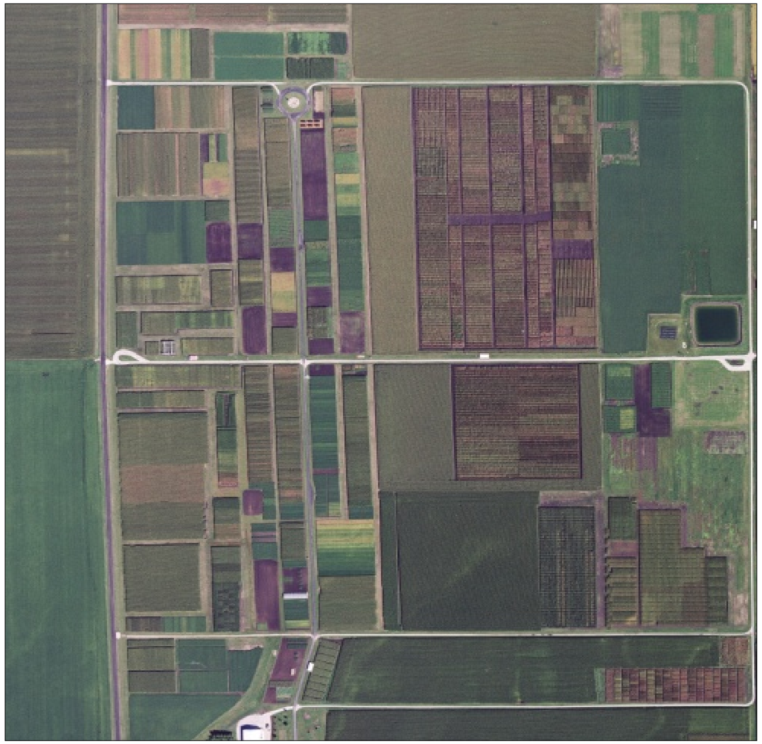
•Trait Integration – Breed new traits into inbreds/hybrids and test for effectiveness

•Technology Development – Field testing of pipeline traits to generate data for the collaboration

•Collaboration testing done on the corn and soybean projects from Phase 2 through Phase 4

•Largest research farm in North America with 480 contiguous acres committed to applied research with an additional 1,000 leased acres from Eastern Iowa through Western Indiana

•3 greenhouses on site for year round trials



Monsanto and BASF Yield-and-Stress Collaboration Field Tour

Monmouth Research Facility, August 8, 2011

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Biotechnology Lead, Monsanto

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Broad-Acre Higher-Yielding Soybean Family

Marie Petracek
Yield Proof of Concept Platform Lead, Monsanto

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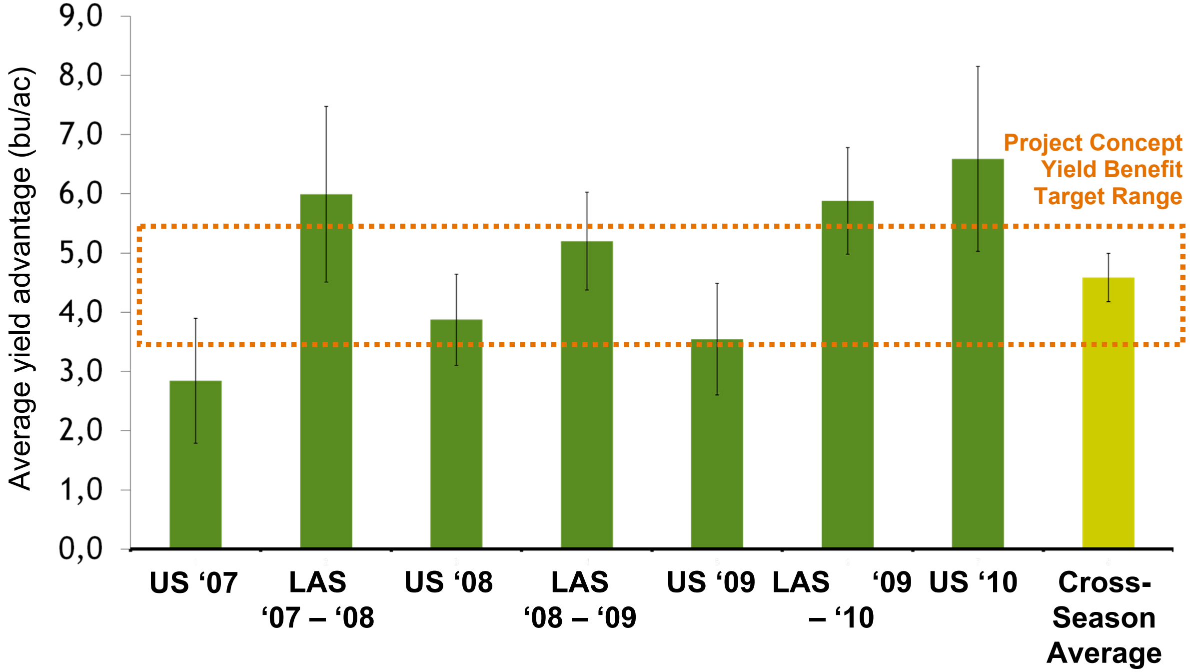
Higher-Yielding Soybeans Showed Improved Yield Across Seven Seasons of Broad-Acre Yield Trials

Higher-yielding soybeans outperform controls in North and South American trials



- Lead event shows an average yield advantage of greater than 7.6 percent over controls in meta-analysis across 7 seasons of testing across North and South America
- Developing regulatory data for phase advancement

Error bars show standard error

Higher-yielding soybeans:
Lead project (Status: **Phase III**)

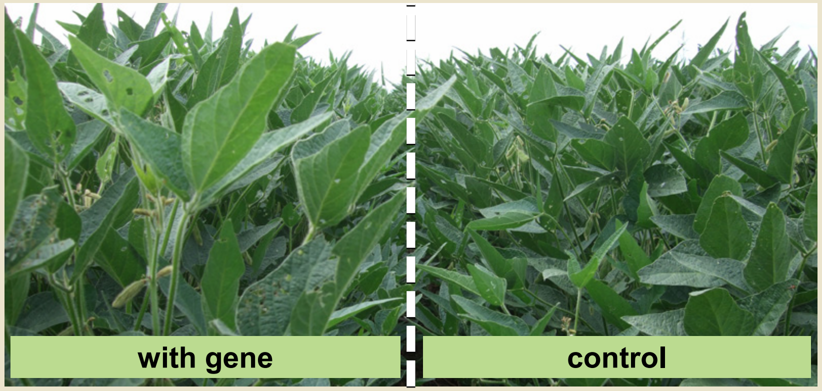
Family value considerations:

- Launch-Country Acres[1]: 35M – 45M
- 2020 Value[2]: $250M – $500M

Sources of value:

Improved yield: Intrinsic yield improvement through insertion of key genes

New Richmond, Indiana – 2010



1. Acre opportunity reflects acres where technology fits at Monsanto's 2010 share in respective crops
2. 2020 value reflects gross sales opportunity of trait family in launch country in year 2020

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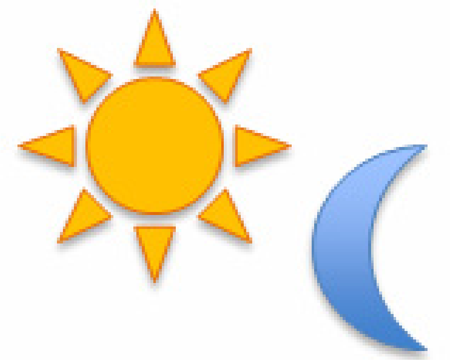
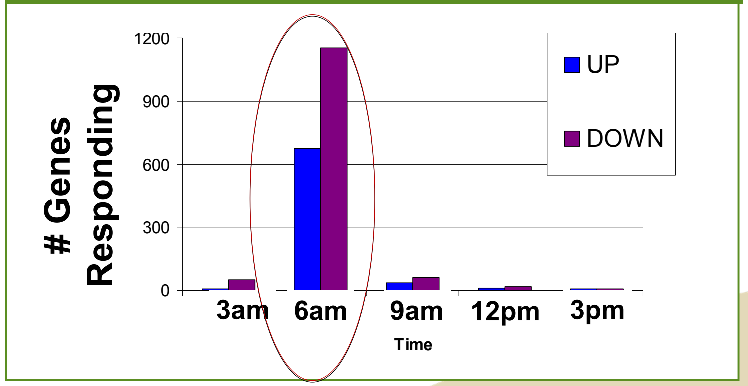
How it Works: New Mechanism for Yield Improvement Described

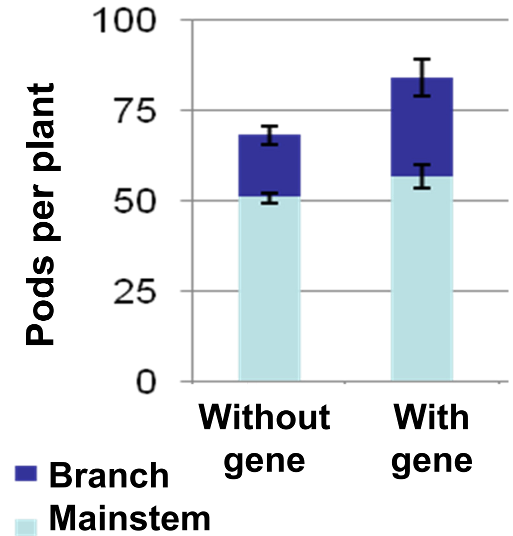


Plants have a day-night cycle

With gene, most changes around dawn

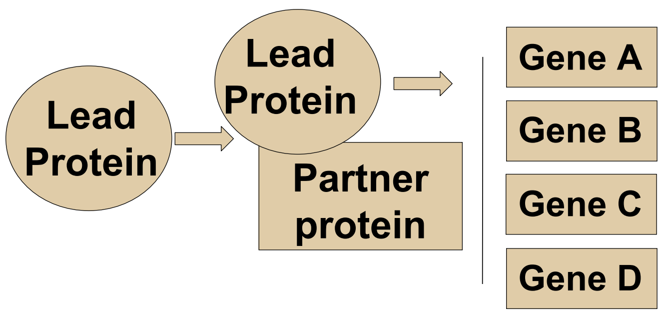


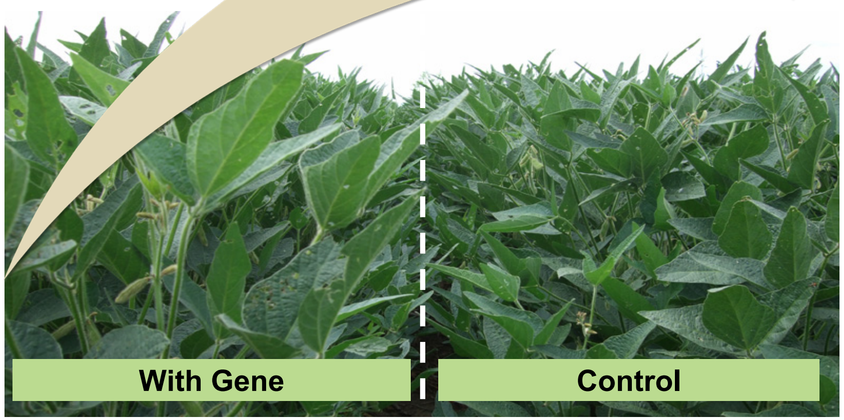
Yield



Turns plant's genes "on" and "off" cycle

Transcriptional regulation

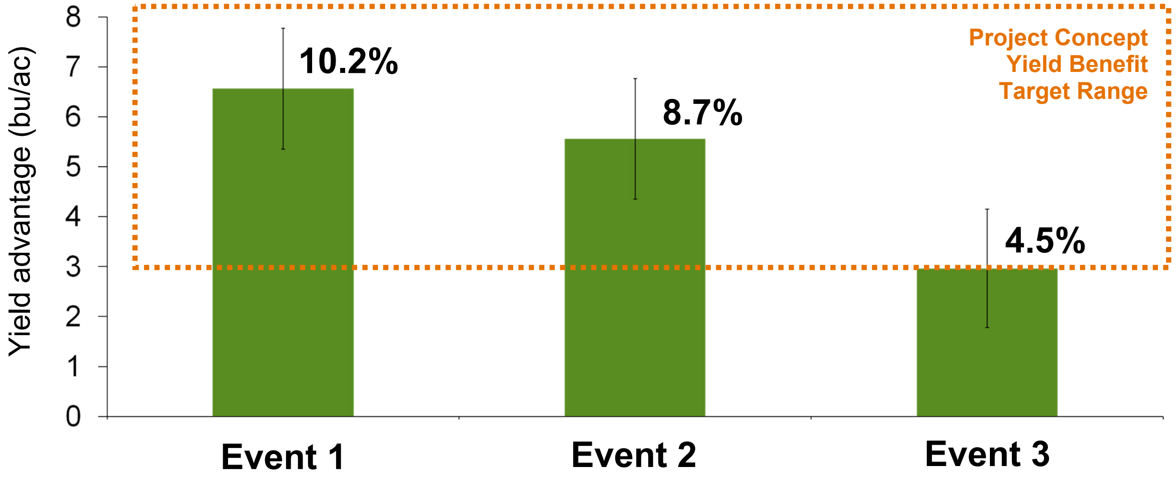




Modification of the plant's growth system

Second-Generation Higher-Yielding Soybeans Advanced; Designed to Enhance Yield Over First-Generation Technology

Second-generation yield lead efficacy demonstrated in two consecutive years and across 14 environments in 2010 with comparator as parental line without gene



14 locations, 2 reps

- Consecutive years of consistent increased yield performance of gene across multiple environments
- Field testing data demonstrates that successive traits create an additive yield effect within project concept target
- This is a second-generation trait intended to be stacked with first-generation and designed to provide a step-change in yield potential over first-generation technology

Higher-yielding soybeans:
Second-generation project
(Status: **Advanced Phase II**)

Family value considerations:

- Launch-country acres[1]: 35M – 45M
- 2020 value[2]: $250M – $500M
- This project is aimed at boosting yield potential of soybeans through insertion of genes designed to increase soybean yields

Second-generation stack product concept testing:

Stacks of first-generation with second-generation higher-yielding soybeans show up to 7 percent yield improvement over first-generation higher-yielding soybean trait

1. Acre opportunity reflects acres where technology fits at Monsanto's 2010 share in respective crops
2. 2020 value reflects gross sales opportunity of trait family in launch country in year 2020

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Dicamba Chemistry

Alyson Emanuel
Vice President, Global Marketing Herbicides, BASF

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Monsanto and BASF Collaboration on Dicamba
Innovative New Formulations, Proven Chemistry

Weed	Average Control Rating Glyphosate	Dicamba
Velvetleaf		
Pigweed spp.*		
Ragweed spp.*		
Lambsquarters		
Marestail*		
Sunflower		
Morningglory spp.		
Smartweed spp.		
Nightshade spp.		
Cocklebur		

** Denotes existence of glyphosate resistant populations*

Description	Rating	Highlight
Excellent	9-10	
Good	8	
Fair	6-7	

- Complementary to glyphosate, dicamba provides additional broadleaf weed control and a different mode of action to manage weed resistance
- BASF R&D delivering new formulations, improving performance and complementing the DT system
- Joint development of stewardship, education programs and best practices will support long term sustainability of the DT system
- The dicamba and glyphosate tolerance trait stack will be a powerful next generation tool for growers to control weeds

2011 Soybean Field Trial Results, North Carolina, USA*

Untreated

Residual + Glyphosate

Residual + Glyphosate + Dicamba

*** Monsanto field trial: Dicamba-tolerant *Genuity Roundup Ready 2 Yield* Soybeans,glyphosate-resistant palmer amaranth**

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Drought-Tolerant Corn Family

Dusty Post
Global Corn Technology Lead, Monsanto

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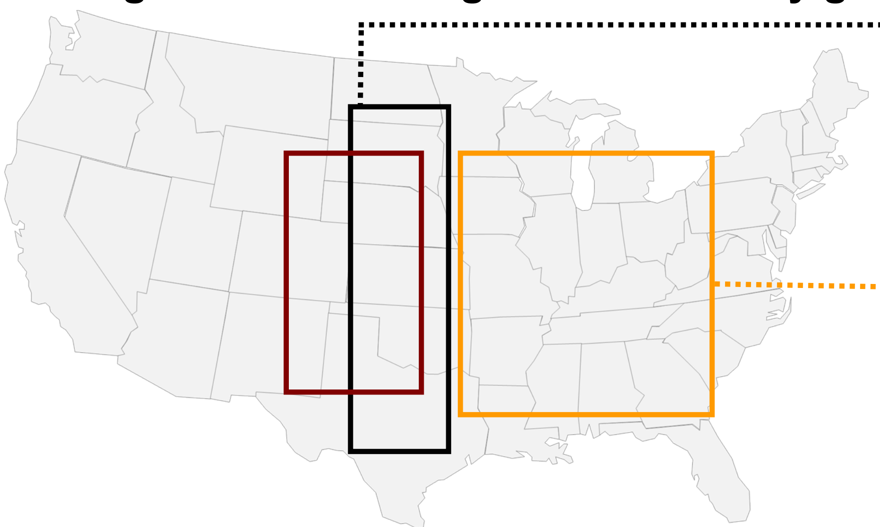
First-Generation Drought Regulatory Submissions Complete; Post-Registration On-Farm Trials Planned for 2012

Drought tolerance: Segmented value by geography



Target geography for first-generation drought-tolerant corn (Phase IV) is the ~10M acre segment of the Western Great Plains

Second-generation drought-tolerant corn (Phase II) designed to build out the family of traits and reach the insurance acres of the Central Corn Belt

Western dryland ~10M acres | Irrigated 8M-12M acres | Stability 60M-70M acres

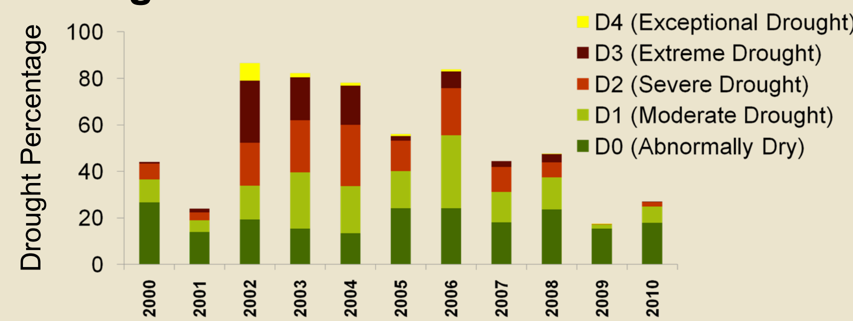
- All regulatory submissions for planting and import have been made; on track for U.S. de-regulation on 2012 timing
- 2010 marked the third year of minimal drought conditions in the testing environment generating limited data
- Post-registration, Monsanto will apply lessons learned from previous launch experiences to build hybrid portfolio to guide commercial approach
- In 2012, expect to use on-farm plots with key growers to generate data on hybrid performance

Drought-tolerant corn:
First-generation project (Status: **Phase IV**)

First-generation drought I:
- Launch-country acres opportunity[1]: ~10M
- Accessible market: Western dryland corn

Family value considerations:
- Launch-country acres*: 45M – 55M
- 2020 value[2]: $250M – $500M
- Reduces yield losses in water-stressed environments

Drought conditions: Testing season environments



Source: USDA Drought Monitor

1. Acre opportunity reflects acres where technology fits at Monsanto's 2010 share in respective crops
2. 2020 value reflects gross sales opportunity of trait family in launch country in year 2020

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Maximizing Drought Tolerance by Pairing Superior Biotech Genes with the Best-Yielding Germplasm

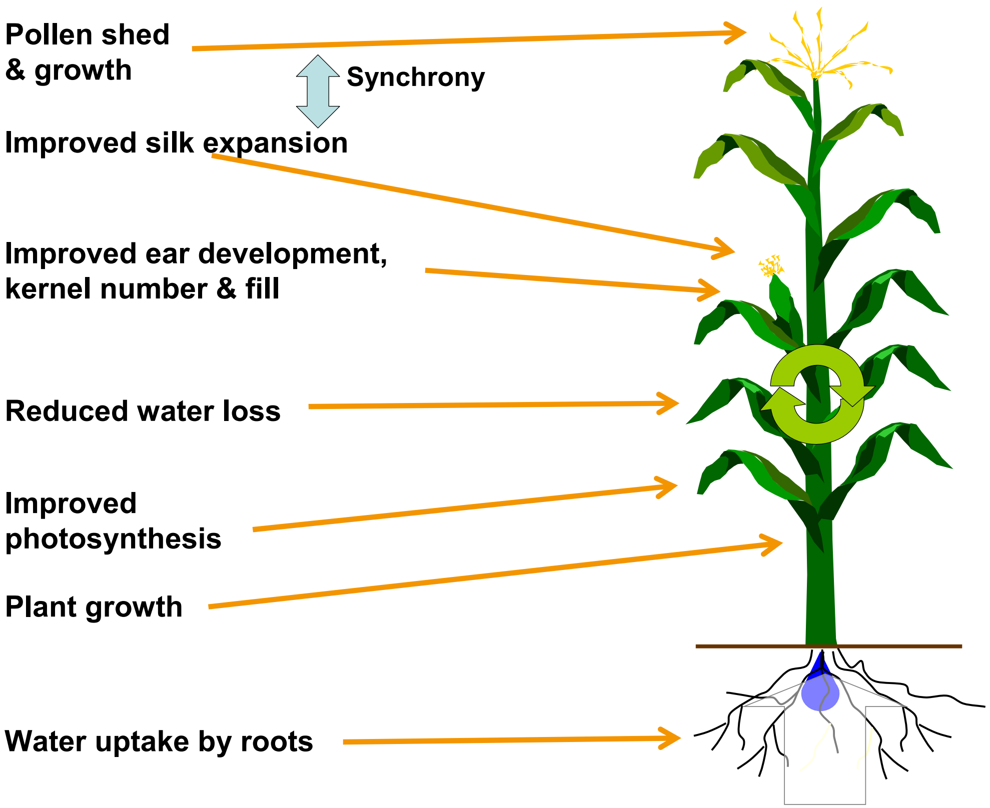
Monsanto breeders characterize germplasm for response to drought stress

Genetic variation for stress tolerance exists in elite germplasm pools

- Drought tolerance is a complex characteristic to convey in plants
- Many mechanisms and genes are involved in complex traits
- Pairing specific combinations of germplasm and biotech trait may do more to address the many mechanisms impacting quantitative traits
- Our approach to helping farmers manage drought is a systems-based approach:
  - Traditional plant breeding / native genes
  - Agronomic components
  - Biotechnology traits

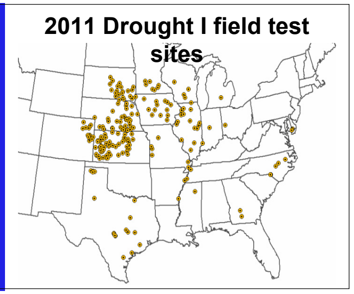
Next-Generation of Drought-Tolerance Genes are in Testing Using Breeding and Biotechnology

The complexity of plant biology…



… requires advanced R&D resources

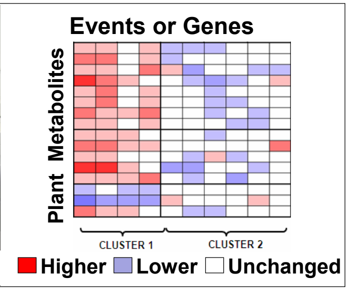
Early screening for leads is conducted with automated greenhouse and extensive field testing



Followed by physiological & biochemical characterization: Look outside and inside the plant

Control With Gene

BASF Berlin Lab



Building a family of traits conveying drought tolerance in corn

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Broad-Acre Higher-Yielding Corn Family

Tom Ruff
Director, Yield and Stress Traits, Monsanto

Higher-Yielding Corn Continue to Demonstrate Improved Yield Over Conventional Control

Higher-yielding corn – 2010 testing

Jerseyville, Illinois: July – September 2010

Higher-yielding corn lead event

Hybrid with Gene

Hybrid without gene

- More yield means more value to farmers through enhanced productivity per acre
- Trials in 2011 will expand testing in commercial germplasm

Higher-yielding corn:
Lead project (Status: **Phase II**)

Project concept:
Higher-yielding corn is aimed at boosting the intrinsic yield potential of corn hybrids

Family value considerations:
- Launch-country acres[1]: 45M – 55M
- 2020 value[2]: >$500M

Higher-yielding corn lead event showing a yield advantage over paired control

1. Acre opportunity reflects acres where technology fits at Monsanto's 2010 share in respective crops
2. 2020 value reflects gross sales opportunity of trait family in launch country in year 2020

Inherent Yield Can Be Enhanced By Improving Plant's Potential to Capture Light, Convert CO_2 to Carbohydrate, and Partition to Grain

Yield potential

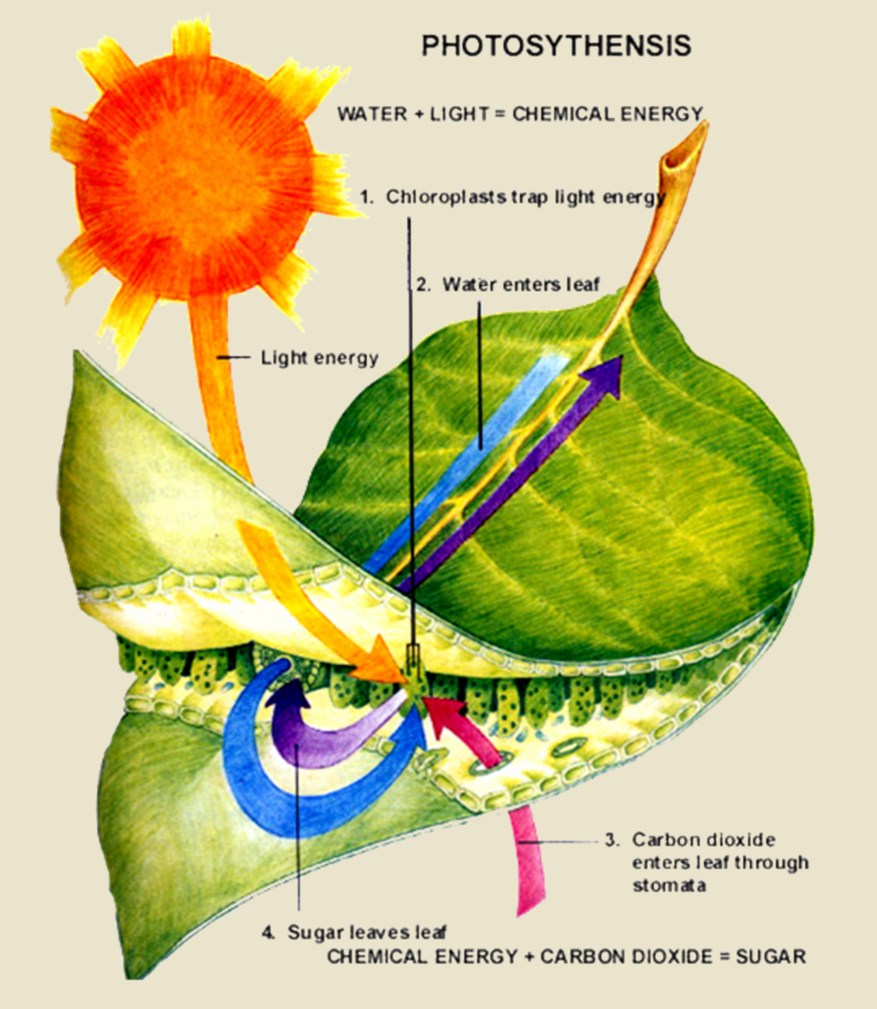
- Based on academic studies and U.S. yield contests, corn has potential to achieve >300 bu/acre under optimal conditions
- Yield potential (YP) is determined by a combination of factors:
  - Ability to harvest light
  - Conversion of sunlight into carbohydrate
  - Partitioning carbohydrates to kernel development

Improvement in any one of these factors will increase plant's inherent yield potential

Yield gap (yp + environment)

- 2010 USDA average corn yield = 153 bu/acre
- The difference between 153 and 300 bu/acre is due in part to suboptimal environmental conditions
  - Water (i.e., drought)
  - Fertility (i.e., nitrogen)
  - Disease/insect/weed pressure
  - Climate (heat or cold stress)

Improving the plant's ability to tolerate these stress factors will narrow the yield gap and ensure crop is yielding to its potential



http://www.colorado.edu/UCB/AcademicAffairs/ArtsSciences/MCDB/MCDB5810/graphics/photosynthesis.jpg

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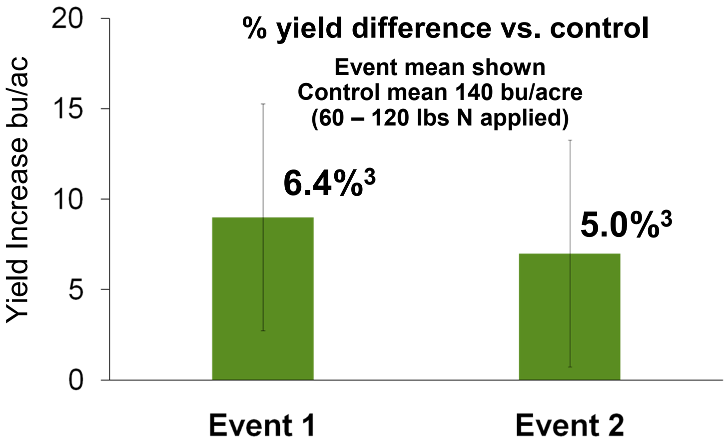
Nitrogen-Utilization Corn Family

Janice Edwards

Yield Collaboration Platform Lead, Monsanto

Nitrogen-Utilization Corn Advanced Into Expanded Phase II Testing; Network Established For Critical Evaluation of Leads

2010 nitrogen utilization testing:
Top nitrogen lead performs across two years of testing under nitrogen limitation



Events mean demonstrate a >5% yield increase versus control

Yield efficacy demonstrated across 17 environments in two years of testing under reduced nitrogen treatment

Error bars – LSD 10

- Project advanced into expanded Phase II testing to develop several years of data showing performance of the gene across environments, and across germplasm backgrounds
- Developed a multi-location managed nitrogen testing network to enable rapid identification and development of future products

1. Acre opportunity reflects acres where technology fits at Monsanto's 2010 share in respective crops
2. 2020 value reflects gross sales opportunity of trait family in launch country in year 2020
3. significant at p $\leq$ 0.1

Nitrogen-utilization corn:
Lead project (Status: **Advanced Phase II**)

Family value considerations:

- Launch-country acres[1]: 45M – 55M
- 2020 value[2]: $250M – $500M
- Targets ways that corn plants can use nitrogen more efficiently, exploring the potential to boost yield under normal nitrogen conditions or to stabilize yield in reduced nitrogen environments

Nitrogen field testing:
Jerseyville, IL- June 2010

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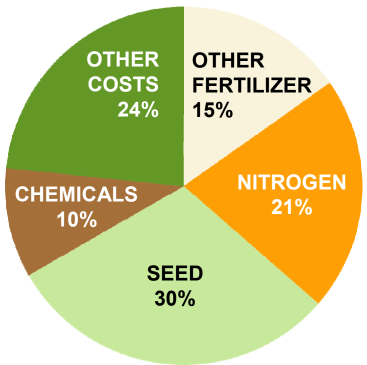
Improving Nitrogen-Use Efficiency in Corn Provides an Opportunity for Increased Farmer Profitability

2010 U.S. Corn production operating costs per acre[1]

2010 USDA operating costs[1]: $275/ac



- All else equal, a 1% reduction on an operating input cost, improves farmer profitability by up to ~$1.00 per acre
- However, a 1% increase in yield, improves farmer profitability by ~$8.00 per acre

Processes that impact nitrogen use

Storage and remobilization

C/N balance

Amino acids
Proteins
Chlorophyll

↑

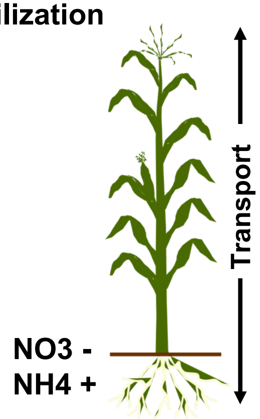
Assimilation

↑

Uptake

↑

Sensing



Pathway	Leads
Enhanced nitrogen uptake/transport	✓
Improved nitrogen assimilation	✓
Enhanced protein synthesis	✓
Improved photosynthesis	✓
Improved general stress response	✓
Pathway regulation	✓

Nitrogen impact corn:

- 2011 USDA forecast per acre average application is 140 pounds of nitrogen at a cost of approximately $70 per acre[2]
- Nitrogen accounts for approximately 60 percent of the total fertilizer cost for a corn producer
- Nitrogen efficiency would offer farmers one way to reduce agriculture's impact on the environment

1. Excludes overhead costs, including hired labor and opportunity cost of land. Source: USDA data tables. Gross revenue assumes 2010 USDA corn yield of 159 bu/acre and 2010 USDA corn prices range of $5.15 to $5.35 per bushel
2. Source: USDA data tables, cost per acre calculated assuming recent 2011 average nitrogen price of $0.57/lb

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Advances in Agriculture

Troy Coziahr
Learning Center Manager, Monsanto

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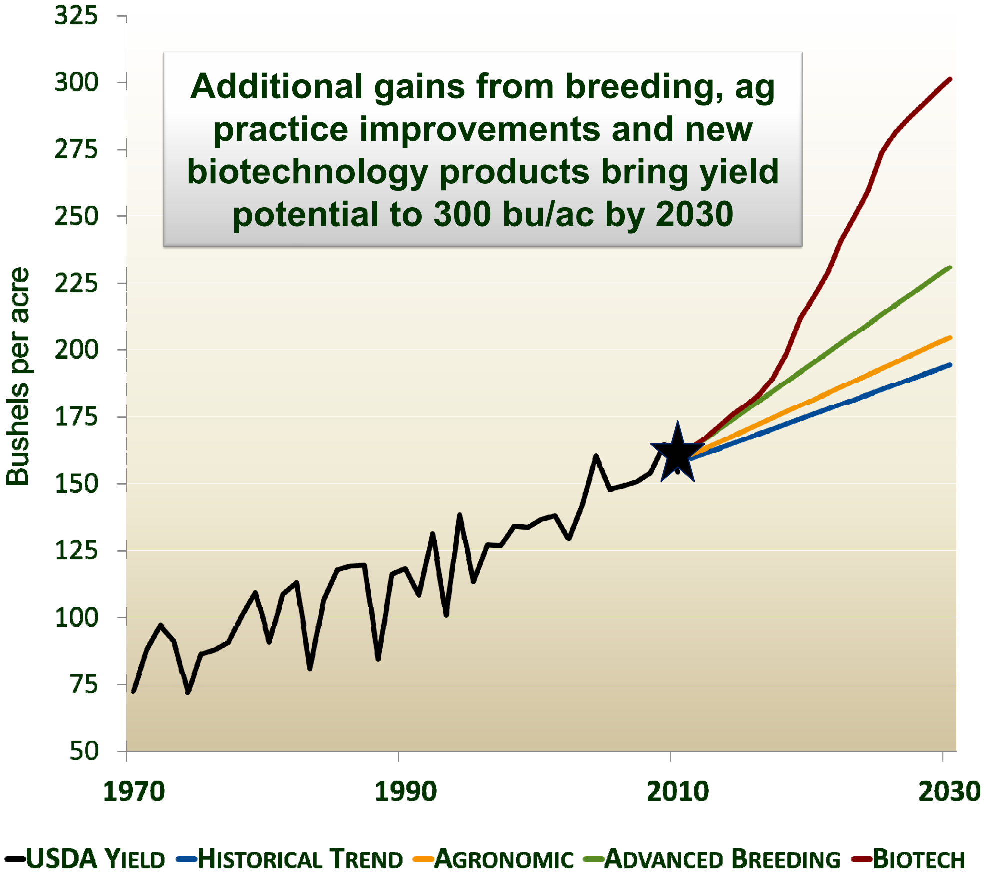
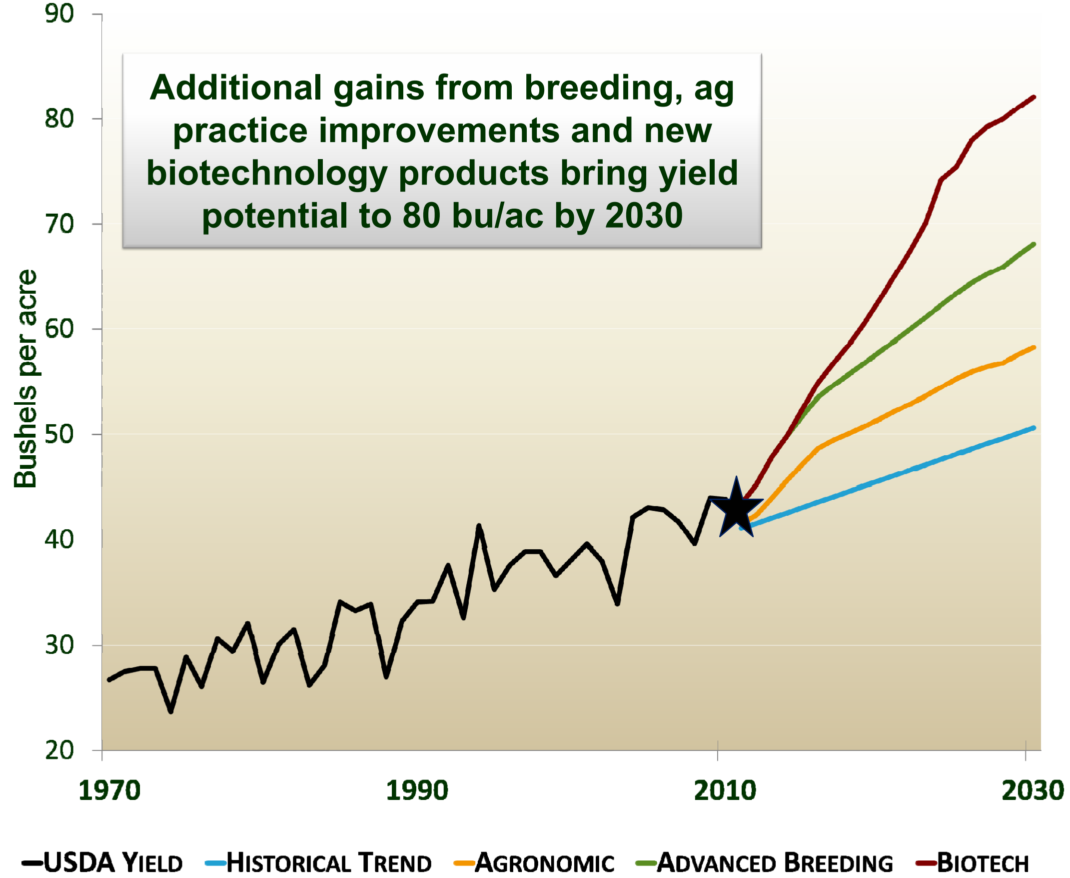
Biotechnology is the Leading Driver of Potential Yield Gains in Corn and Soybeans

Corn yield potential to 2030 in the United States



Soybean yield potential to 2030 in the United States



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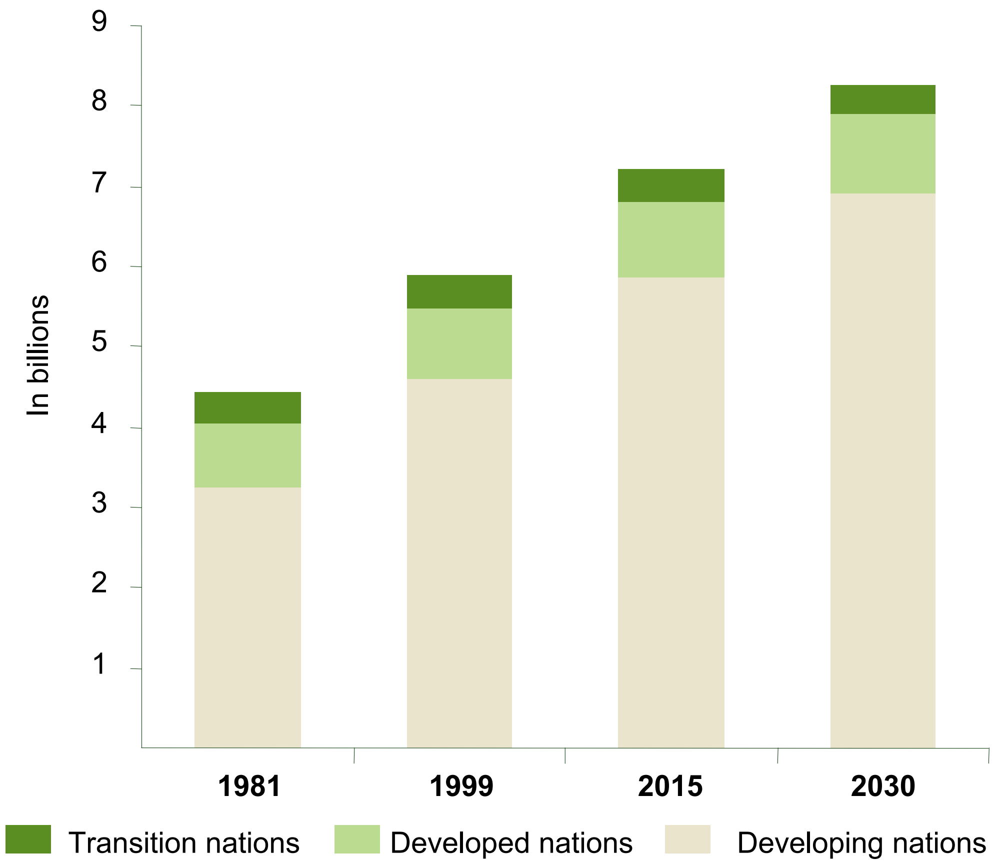
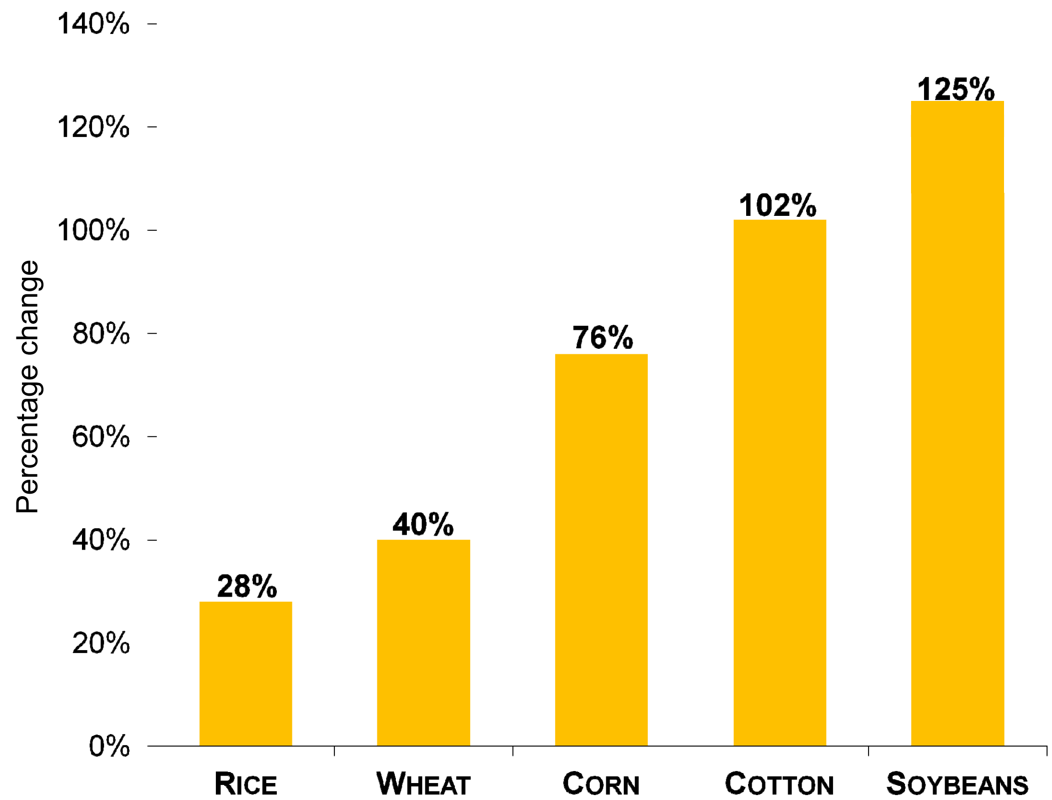
Global Demand for Crops Projected to Grow Dramatically as Population and Incomes Continue to Rise

Growing world population 1981 – 2030E



Increase in demand in key global crops 2000 – 2030E



Sources: FAO "world agriculture: towards 2015/2030. Summary report"; IHS global insights, agriculture division

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