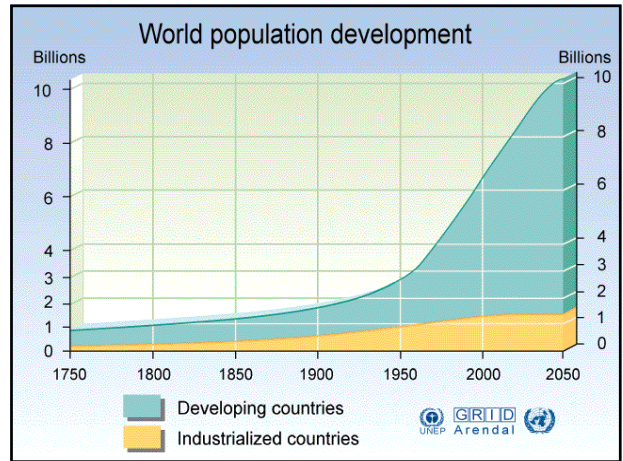




Plant Biotechnology
A Decade of Progress,
A Promising Future

Peter H. Raven

Madrid November 21,

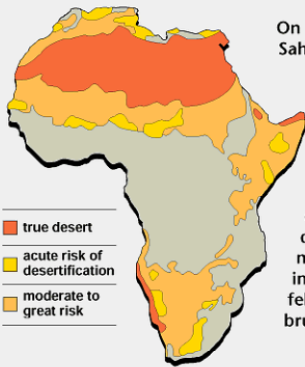


Changes since 1950

- Soil erosion 20%
- Loss of agricultural land 18%
- Loss of forests 1/3
- Atmospheric CO₂ 1/6 increase
- Stratospheric ozone 6-8% loss



SPREADING DESERTS THREATEN AFRICA



On the southern edge of the Sahara, an area the size of Somalia has become desert over the past 50 years. The same fate now threatens more than one-third of the African continent. The main cause of desertification is not drought but mismanagement of land, including overgrazing and felling of trees and brushwood for fuel.

Source: The Conservation and Rehabilitation of African Lands (FAO 1990)

Use of the Earth's Land Surface

- Approximately 11% is currently devoted to crop agriculture
- With a few exceptions, the cerrado of Brazil being one, all of the land that can be cultivated is being cultivated
- Some arable land is being lost each year
- More than 20% of the Earth's land surface is used for natural pastures, most of them unsustainable.



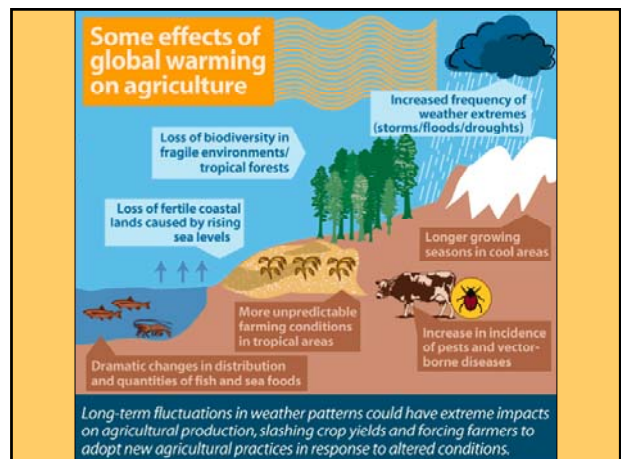
Malnourishment Facts

- 50% of the world's population lives on under \$2 a day.
- One in eight people is starving.
- One in two people is malnourished.

Photo by Francesco Zizola / Magnum Photo



Rainforest foods



How many planets do we need?

To support everyone at the current standard of living and population



How many planets do we need?

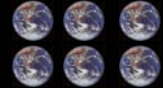
To support everyone at current standards if the population doubled



To support the current population at the standard of developed countries



To support everyone if both the population and standards increased



Tibetan girl gathering firewood
Langtang, Nepal

How Do We Move Forward?

- We attain global sustainability as a condition for human progress
- We must address population, consumption, and technology simultaneously to move toward that goal
- Agriculture is a key component that will both affect our ability to attain sustainability and will depend on sustainability being achieved

Future Agriculture

To Support Everyone Adequately
Many Improvements Will Be Necessary

- Integrated pest management
- Reduction of chemical use
- Water conservation
- No-till practices
- Precision agriculture
- Conserving genetic diversity
- Specialized crops
- Genetic modification by traditional and contemporary methods





PLANT BIOTECHNOLOGY
PROVEN • PROMISING

Centuries of plant improvement provide modern plants such as corn

Teosinte Modern corn

PLANT BIOTECHNOLOGY
PROVEN • PROMISING

Plant biotechnology: precise and predictable plant breeding

Traditional plant breeding

DNA is a strand of genes, much like a strand of pearls. Traditional plant breeding combines many genes at once.

Traditional donor (Desired Gene) × Commercial variety = New variety (many genes are transferred) (Desired gene)

Plant biotechnology

Using plant biotechnology, a single gene may be added to the strand.

Desired gene (transfers) + Commercial variety = New variety (only desired gene is transferred) (Desired gene)

10 Years of Plant Biotechnology

- In 2005, farmers around the world harvested biotech crops for the 10th year
- 10 years of commercial experience on over 1 billion acres demonstrates:
 - Proven economic and environmental benefits
 - Solid record of safety
 - Promising future benefits from new products

Plant Biotechnology: Proven • Promising

- **Global Adoption**
 - Proven Benefits
 - Safety Record
 - Promising Future

PLANT BIOTECHNOLOGY
PROVEN • PROMISING

Farmers choose to plant more biotech crops each year

- 8.5 million farmers
- 21 countries
- 500,000+ biotech acres harvested each day*

Crop	% Biotech Global
Soybeans	56
Cotton	28
Canola	19
Corn	14

Annual Acres Planted (million)

↑ +10% CAGR since 1996

ISAAA 2005 * Linear average over 365 days

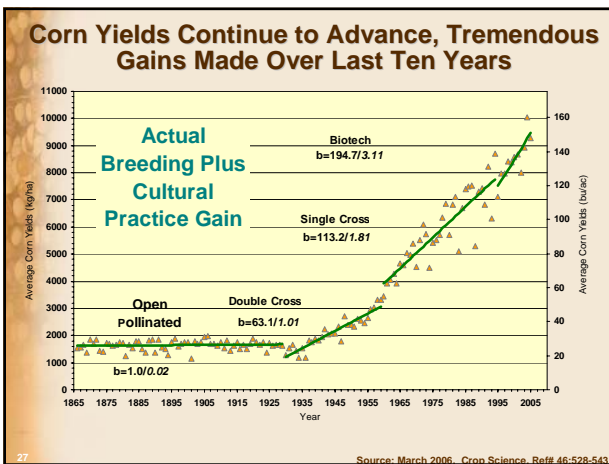
Farmers choose biotech crops

“Farmers have made up their mind... they continue to rapidly adopt biotech crops because of the significant agronomic, economic, environmental, and societal benefits.”

- Clive James, ISAAA

Plant Biotechnology: Proven • Promising

- Global Adoption
- **Proven Benefits**
- Safety Record
- Promising Future



Recent study confirms benefits of biotech crops worldwide

Global Impacts of Biotech Crops since 1996:

- Increased net income for farmers by more than **\$27 billion**
- Increased net income for farmers in the U.S. by **\$10.8 billion**
- Increased net income for farmers globally by nearly **\$6.5 billion** in 2004
- Reduced pesticide applications by **379 million pounds**
- Decreased diesel fuel use by farmer by **464 million gallons**
- Decreased greenhouse gas emissions (CO₂) by **22 billion pounds**

- 8.5 million farmers in 21 countries plant biotech crops
- 90% of biotech crop farmers from developing countries
- One billion+ acres harvested

Source: G. Brookes, PG Economics 2005

Biotech crops continue to deliver impressive environment benefits

- Reduced pesticide applications of **379 million pounds** active ingredient
- Equivalent to a **15 mile-long train** of railcars filled with pesticide active ingredient

- Reduced or no-tillage practices are enabled resulting in:
 - Reductions in greenhouse gas (GHG) emissions of **22 billion pounds**
 - Equivalent to removing **5 million cars** from the road for one year

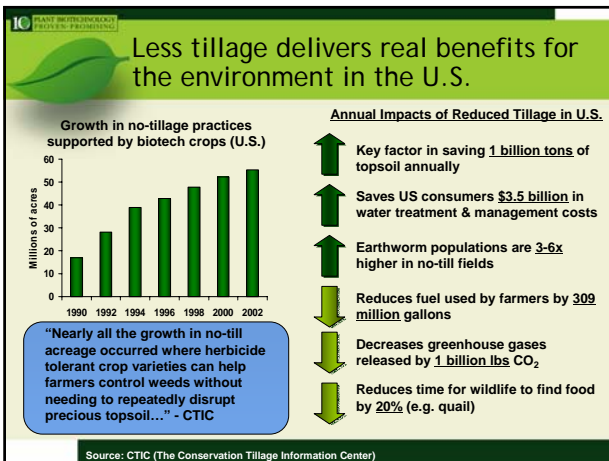
Source: G. Brookes, PG Economics 2005

Biotech crops spur no-till growth in US crop production

“Nearly all the growth in no-till acreage occurred where herbicide tolerant crop varieties can help farmer control weeds without needing to repeatedly disturb precious topsoil...” - CTIC

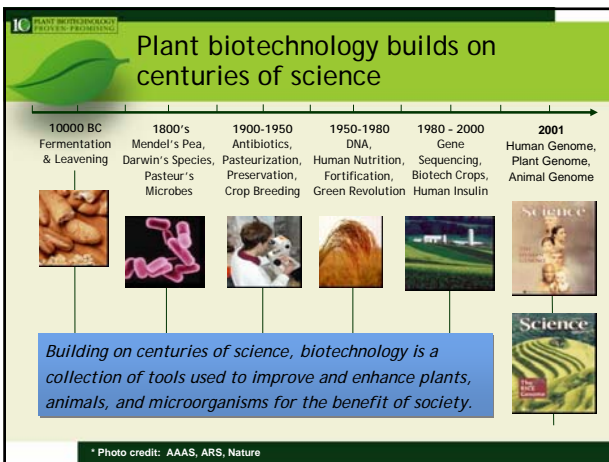
Crop	1996	2000	2004	Change since 1996
Million Acres of No-Till Corn	~13.5	~14.5	~15.5	+20%
Million Acres of No-Till Soybeans	~16	~21	~26	+65%
Million Acres of No-Till Cotton	~0.5	~1.2	~2.2	+3.5x

Source: CTIC



Plant Biotechnology: Proven • Promising

- Global Adoption
- Proven Benefits
- Safety Record**
- Promising Future



Scientific safety evidence is validated and recognized by policy leaders

5 to 10 years to develop a single product safety data package

Roundup Ready® Experience:

- Over 1000 **Study Reports** spanning 10 yrs
- Tens of thousands of **Field Tests** across 15 yrs
- 100k's Compositional **Equivalence Analyses**
- Reviewed by 27 **Regulatory Agencies** in several countries
- Validated by 100's of independent **Academic Institutions** and Private Research Institutes

EU Commission report summarizing 81 biotech research projects " ...the use of more precise technology and greater regulatory scrutiny probably make them even safer than conventional plants and foods" Oct. 2001

Compendium Reference: Monsanto Technical Publications On Agriculture and Biotechnology

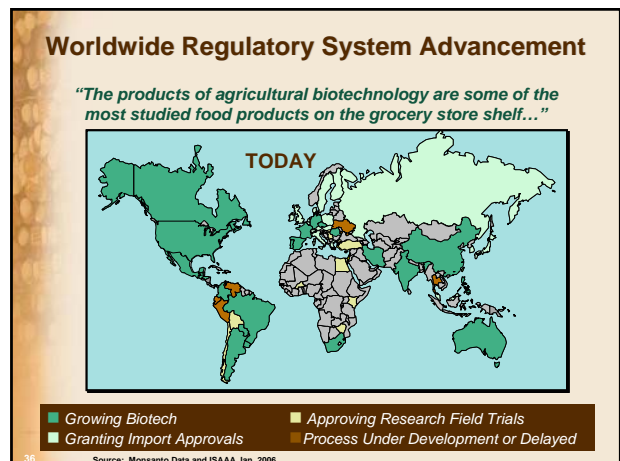
Scientific officials report on the safety and benefits of biotech crops

"...in those countries where transgenic crops have been grown, there have been no verifiable reports of... health or environmental harm."

- FAO

- World Health Organization
- Food & Agriculture Organization (FAO) of the United Nations
- National Academy of Sciences (USA)
- Royal Society (UK)
- American Medical Association (USA)
- French Academy of Medicine
- European Commission
- U.S. Food & Drug Administration
- Society of Toxicology
- Institute of Food Technologists

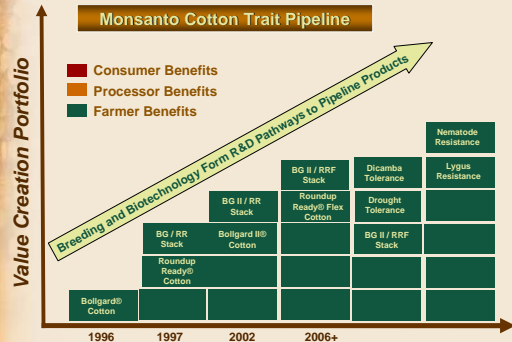
Source: FAO, 2001.



Plant Biotechnology: Proven • Promising

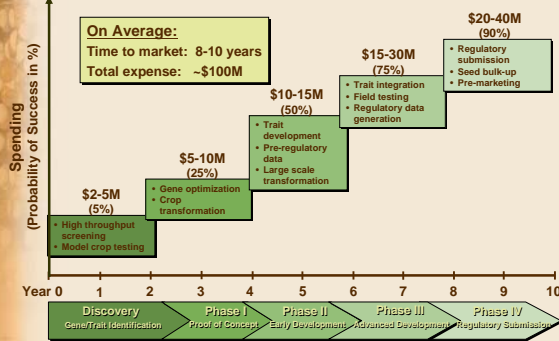
- Global Adoption
- Proven Benefits
- Safety Record
- Promising Future

Expanding the Portfolio Offers Solutions in Cotton in Feed, Food and Yield



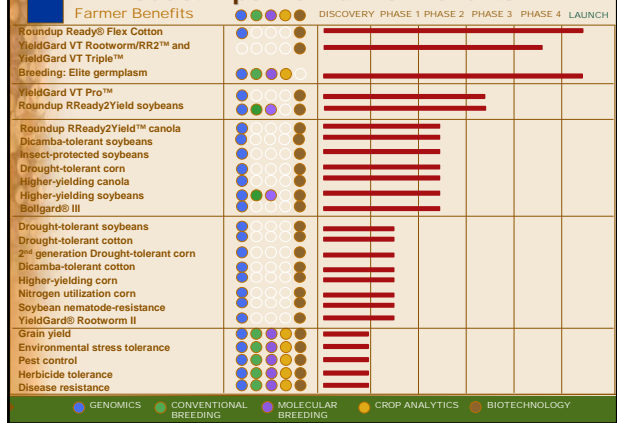
38 Commercialization dependent on many factors, including successful conclusion of regulatory process. Monsanto Company Confidential

Ag Biotech Driven By Lengthy Product Development Cycle And Large Investment Process*



39 *Numbers (time duration, spending, and probability of success) are all estimates. The actual for individual projects could vary.

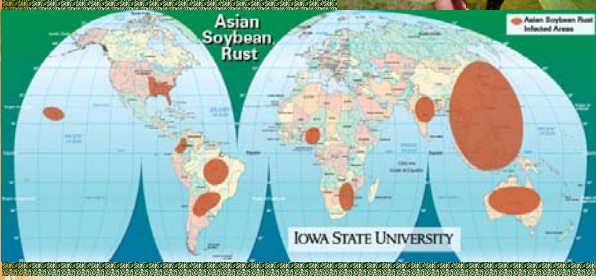
Product Pipeline: Farmer Benefits



Farmer Benefit: Addressing Major Yield and Dollar Losses From Soybean Rust

Soybean Rust Disease Is In All Major Soybean Production Regions Of The World

- Multiple hosts in ~ 30 species of plants
- About 10-50% yield loss (\$7-11B) globally



Farmer Benefit: Overcoming Insufficient Fresh Water for Irrigation

Drought Tolerance Product Concept

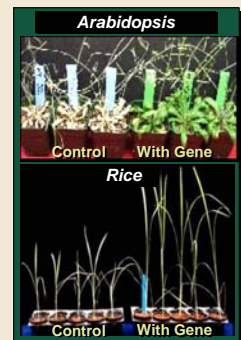
- Yield improvement through water use efficiency
- Yield improvement from water deficit tolerance

Benefit

- Save cost in irrigated acres

Agriculture is responsible for 75% of freshwater withdrawal.

By 2025, Developing Countries will have ~ 300 Million MT grain deficits due to water scarcity.



Farmer Benefit: Using Nitrogen Efficiently

Nitrogen Utilization Genes

Product Concept

- Crops with more efficient nitrogen utilization

Benefits

- Improved crop performance
- Enhanced nitrogen uptake
- Less yield variability
- Greater output per unit input

Tolerance to Low Nitrogen

Darker Green Leaves

Control With Gene

Control With Gene

Discovery Phase 1 Phase 2 Phase 3 Phase 4 Launch

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Consumer Benefit: Reducing Trans Fats for Human Health

Product Concept

- Reduce/eliminate trans fats with increased oil stability
- Achieve yield parity
- Reduce linolenic acid to <3%

Benefit

- Requiring less hydrogenation
- Reduce or eliminate trans fats in food
- FDA requires food manufacturers to label trans fats
- Scientific evidence shows that consumption of trans fats raises LDL ("bad") cholesterol levels that increase the risk of coronary heart disease (CHD)
- According to the NIH, over 12.5 million Americans suffer from CHD, and more than 500,000 die each year

Standard Soybean Low Lin Low Lin - Mid Oleic LL - MO - Low Sat

Linolenic 18:3 Linoleic 18:2 Oleic 18:1 Sats 18:0 / 16:0

Vistive™
A better soybean naturally

Nutrition Facts
Appearing on product labels as of January 2006

Discovery Phase 1 Phase 2 Phase 3 Phase 4 Launch

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Consumer Benefit: Increasing Omega-3 to maintain Heart Health

Product Concept

- Enrich Omega-3 content in biotech oil seeds to 20%
- Improve taste of SDA oil superior to fish oil
- Enhance stability of SDA as an Omega-3

Population Coronary Heart Disease Mortality and Tissue Omega-3 Fatty Acid Content

CHD Mortality

Omega-3 (% of all long-chain PUFA)

USA, Quebec, Quebec Cree, Spain, Quebec Inuit, Japan, Greenland

Source: W. Lands, Lipids 2003; 38:317

- AHA, USDA/DHHS and FDA all have recognized the importance of Omega-3s to maintain heart health
- AHA recommends eating fish (particularly fatty fish) at least two times a week because of Omega-3 fatty acid content

45

Processor Benefit: Processor Preferred® High Fermentable Corn Hybrids Proven to Enhance Ethanol Yields

Ethanol Update

- ▶ Average yield for a conventional dry mill is 2.8 gallons of ethanol for every 1 bushel of corn

Opportunity

- ▶ An ethanol plant that actively sources HFC can improve ethanol yields
- ▶ HFC provided a 2.7% average increase in ethanol yields in large scale commercial trials across 7 states and Canada in 2003-2004
- ▶ Some ethanol plants are paying a premium of \$0.05-\$0.08 per bushel for Processor Preferred HFC hybrids

Ethanol Yield Improvement Through High Fermentable Corn

Use of Processor Preferred® Corn Can Shift the Ethanol Yield Distribution Curve to the Right

Processor Preferred 4.2 Yellow Corn

Number of bushels per acre Gallons of ethanol per bushel of corn

46

Processor Benefit: Breeding and Biotechnology in Corn Provide Greater Yield and Consistency Necessary to Fuel Ethanol Markets

Ethanol Draw Area

- ▶ 290K corn acres required to supply a 100M gallon dry mill

Opportunity

- ▶ Ethanol draw acres are likely to be highly technified with elite Processor Preferred® germplasm combined in a future 4-way stack
- ▶ Monsanto's molecular breeding increases the rate of genetic gain versus conventional breeding

Example: Iowa Ethanol Refineries

DUBUGUE, CEDAR RAPIDS, IOWA CITY, DAVENPORT, BURLINGTON, DES MOINES, AMES, SIOUX CITY

DRAW AREA FOR ETHANOL DRY MILL ETHANOL PLANTS IN PRODUCTION ETHANOL PLANTS UNDER CONSTRUCTION WET MILL

Source: Renewable Fuels Association and Monsanto estimates

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Processor Benefit: Enhancing Essential Amino Acids in Feed

Mavera™ High Value Corn With Lysine

- Enhance level of limiting essential amino acids and corn oil content in feed
- Lower cost of animal production
- Improve animal health
- Increase feed efficiency

Recent U.S. approval makes 1st generation Mavera HVC with Lysine the first crop-based quality trait produced through biotechnology for the animal feed industry

Control Event 1 Event 2

Discovery Phase 1 Phase 2 Phase 3 Phase 4 Launch

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10 PLANT BIOTECHNOLOGY PROVEN. PROMISING.

More than 50 first generation products have commercial approval

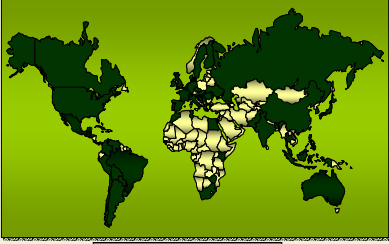
	Canola		Soybeans
	Corn		Squash
	Cotton		Sugarbeets
	Papaya		Sweet Corn
	Potato		Tomato

Source: Council for Biotechnology Information (CBI)

10 PLANT BIOTECHNOLOGY PROVEN. PROMISING.

Plant biotech research is taking place around the world

63 countries conducting research across 57 different crop



Centers of Influence

- Argentina
- Australia
- Brazil
- China
- Europe
- India
- North America
- South Africa


■ Conducting plant biotech research

Source: C.F. Runge, Univ. of Minnesota, 2004

10 PLANT BIOTECHNOLOGY PROVEN. PROMISING.

Plant biotech products are expected to improve incomes around the world

\$210 billion* of new income for global society for the 10 years between 2006-2015



Source: ABARE *Full adoption scenario



10 PLANT BIOTECHNOLOGY PROVEN. PROMISING.

Plant Biotechnology

- 10 years of commercial experience on over 1 billion acres:
 - Proven economic and environmental benefits
 - Solid record of safety
 - Promising future benefits from new products