





GMO 101: Facts to Educate You and Help You to Educate Others About GMO Crops and Foods

Travis Frey, Danielle Fuchs, Chelsey Robinson, Brittania Lebbing, GMOAnswers.

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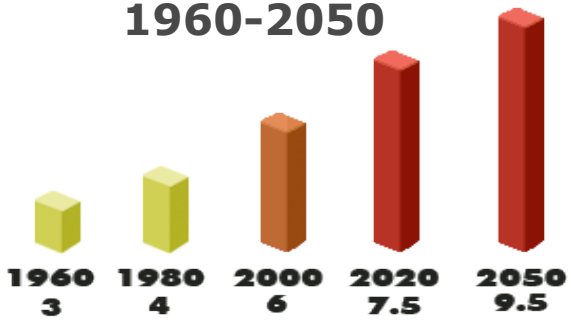
Agriculture is at the center of global trends

Population Growth 1960-2050



Changing Economies & Diets

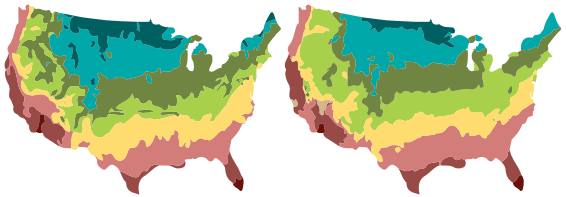
43% increase in calories from animal protein

Demand For Healthier Options

= 2X Food Demand By 2050

in a more challenging production environment

Decreasing Water Availability



Changing Climate & Declining Arable Land

Evolving Ag Policies

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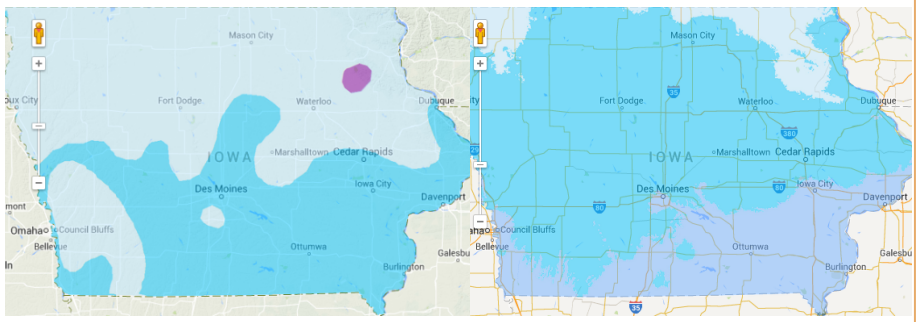
Source: U.S. Census Bureau, International Data Base, June 2010 Update. And UN FOA

Source: Ray DK, Mueller ND, West PC, Foley JA (2013) Yield Trends Are Insufficient to Double Global Crop Production by 2050. PLoS ONE 8(6): e66428.

Climate: greater variability in outcomes

SHIFTING PLANTING ZONES



-25 to -20 (F)

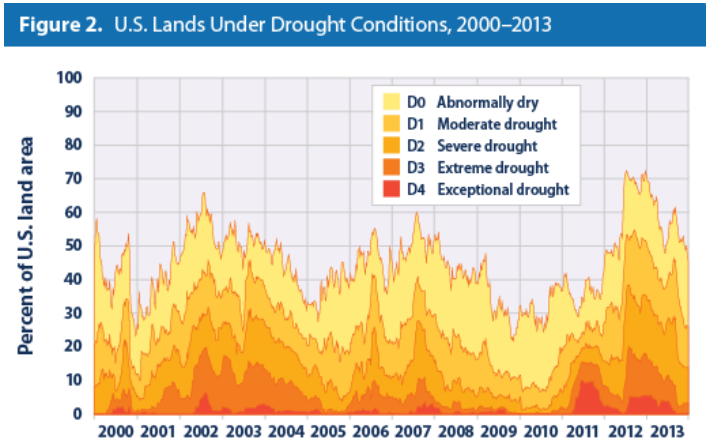
-20 to -15 (F)

1990

USDA Plant Hardiness Zones 2012

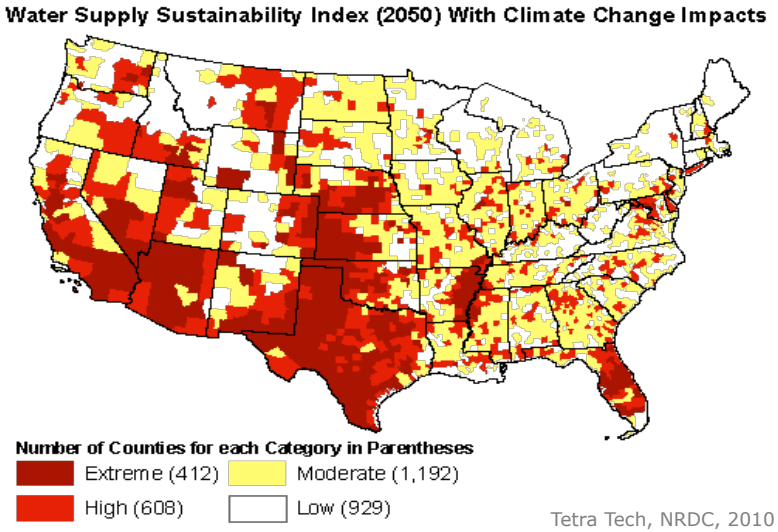
2012

INCREASING ADVERSE WEATHER



Source: National Drought Mitigation Center, 2014

DECREASING WATER AVAILABILITY



Tetra Tech, NRDC, 2010

INCREASING PEST PRESSURE

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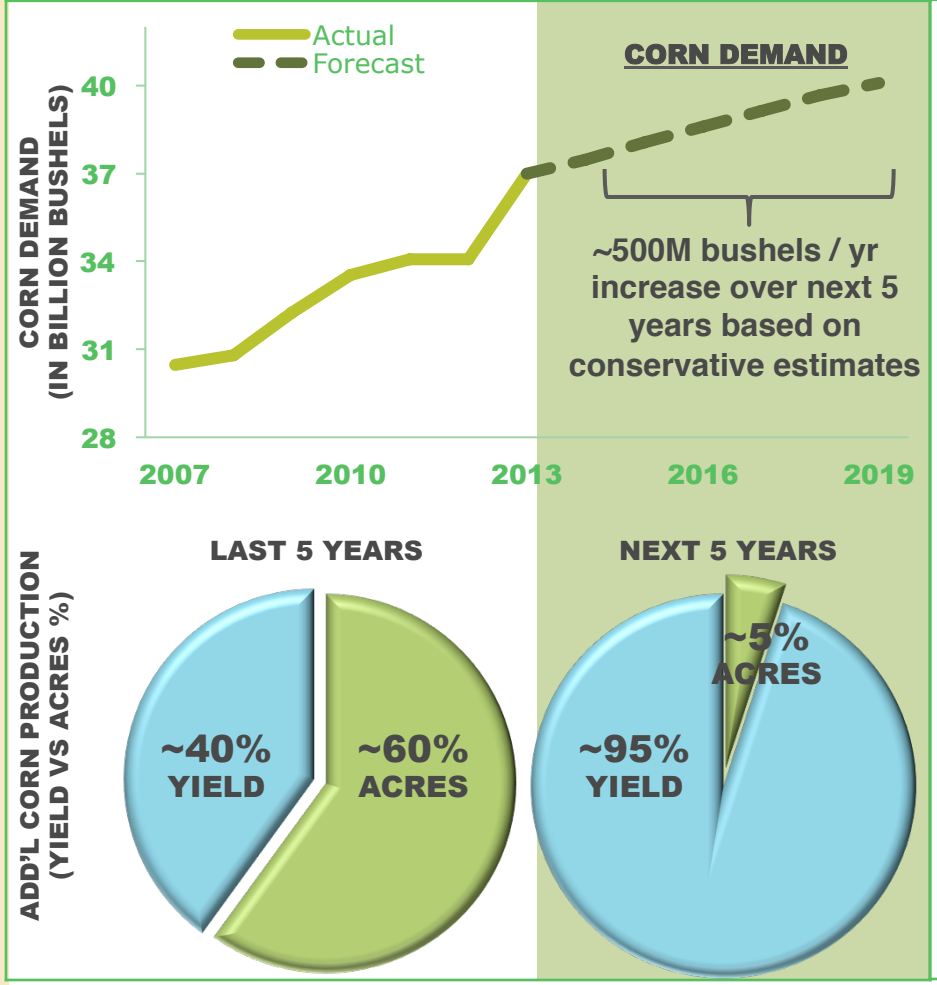
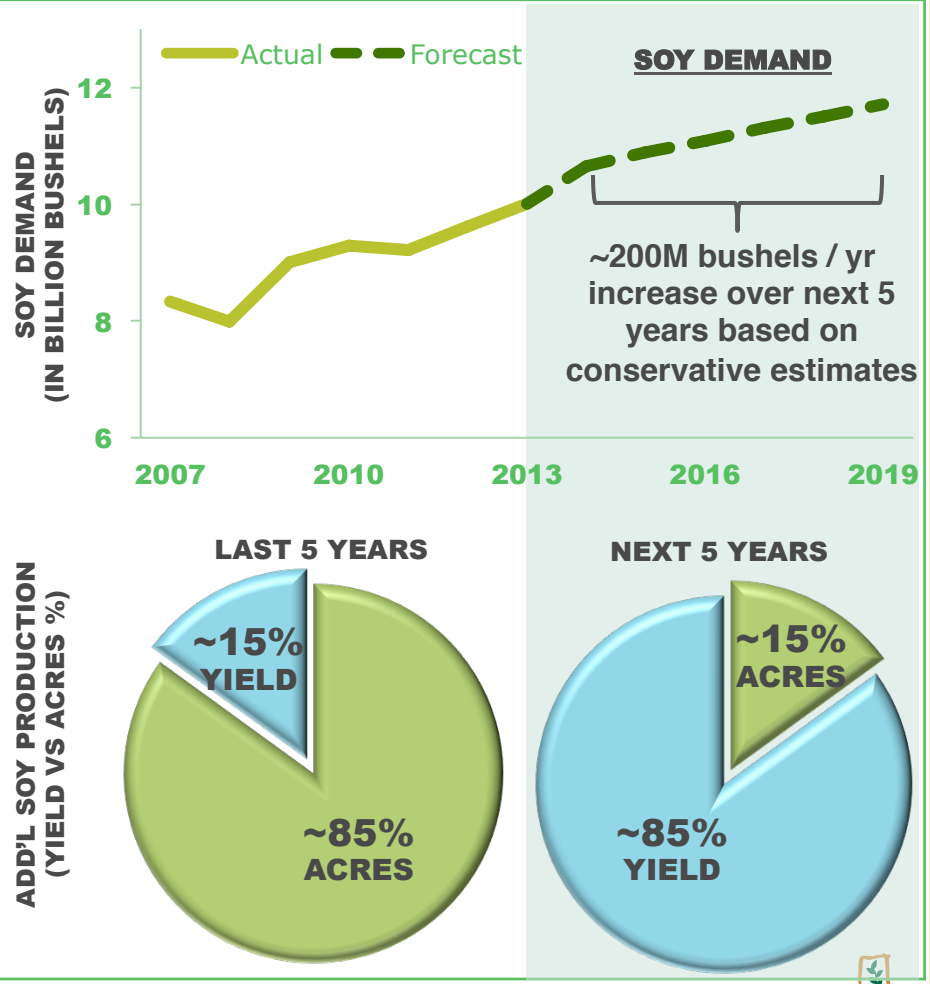
Global need for grain sets important runway for ag sector

CORN DEMAND MOMENTUM
EX: GLOBAL CORN DEMAND ESTIMATES (2007 – 2019F)[1]



SOY DEMAND MOMENTUM
EX: GLOBAL SOYBEAN DEMAND ESTIMATES (2007 – 2019F)[1]



1. USDA historical data, future forecast and projections represent Monsanto internal estimates

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Innovate

To Grow More Food, Safely and Sustainably, Using:

TRADITIONAL BREEDING

BIOTECHNOLOGY

CROP PROTECTION

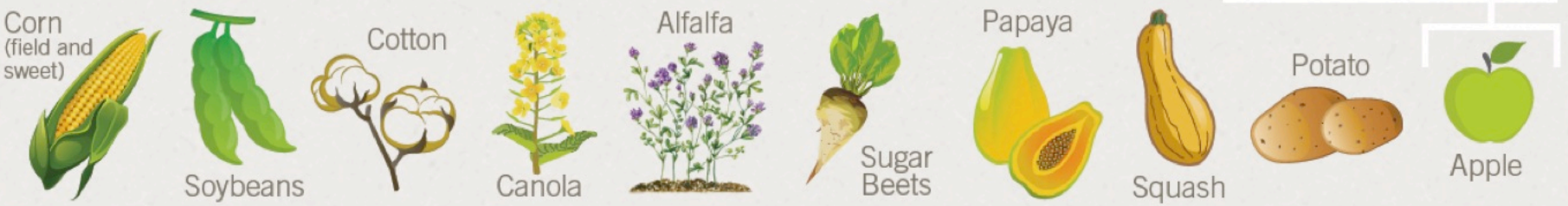
PRECISION AGRICULTURE

GET TO KNOW GMO BASICS

What is a GMO?

GMOs are crops developed with genetic engineering, a more precise breeding technique, that enables someone to take individual traits found in nature and transfer them to another plant, or make changes to an existing trait in a plant.

There are nine GMO crops available in the U.S. today with one more approved and coming to market soon



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Biotechnology is also Used
in Many Additional Common Products

Enzymes

Nearly all cheese is made using rennet produced through biotechnology

Yeast

Scientists use biotechnology to create unique yeast strains for use in brewing beer and making bread

Medicine

Most insulin used by diabetics is produced through biotechnology

Source: http://www.nature.com/scitable/knowledge/library/history-of-agricultural-biotechnology-how-crop-development-25885295

GET TO KNOW

GMO BASICS

How We Got Here

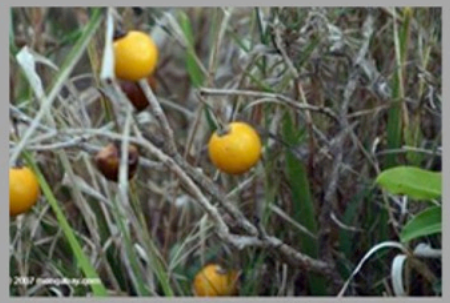
GMO Answers - https://gmoanswers.com/sites/default/files/Get_to_Know_GMO_Presentation.pptx

GET TO KNOW GMO BASICS

watermelon


corn


banana


aubergine / eggplant


carrot


cabbage, kale, broccoli, etc.

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GET TO KNOW GMO BASICS

Methods of Plant Breeding

Traditional

The traditional plant breeding process introduces a number of genes into the plant. These genes may include the gene responsible for the desired characteristic, as well as genes responsible for unwanted characteristics.

Donor Variety DNA Strand
DNA strands contain a portion of an organism's entire genome.

Recipient Variety DNA Strand

New Variety DNA Strand
Many genes are transferred with the desired gene.

Genetic Engineering

Genetic engineering enables the introduction into the plant of the specific gene or genes responsible for the characteristic(s) of interest. By narrowing the introduction to one or a few identified genes, scientists can introduce the desired characteristic without also introducing genes responsible for unwanted characteristics.

Donor Organism DNA Strand
The desired gene is copied from the donor organism's genome.

Recipient Variety DNA Strand

New Variety DNA Strand
Only the desired gene is transferred to a location in the recipient genome.

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GET TO KNOW GMO BASICS

Why GMO? SEED IMPROVEMENT

SEED IMPROVEMENT TECHNIQUE	SELECTIVE BREEDING 10,000 years ago to today	INTERSPECIES CROSSES late 1800s to today	MUTAGENESIS 1930s to today	TRANSGENESIS (GMOs) 1990s to today
What is it?	Combining traits from similar and dissimilar plants by crossing into one genetic background with improved traits	Breeding and tissue culture techniques that permit genetic exchange between plants not crossing naturally	Using chemicals or radiation on seeds to change DNA and occasionally induce a favorable trait	Adding a specific, well-characterized gene to a new seed to transfer a specific trait
Examples	 Almost everything we eat	 Pluots, tangelos, some apples, rice and wheat	 Many plants and fruits including pears, apples, rice, yams, mint, some bananas	 Alfalfa, canola, corn (field and sweet), cotton, papaya, potatoes, soybeans, squash, sugar beets. Apples approved and coming to market soon.
Improved by breeding?	YES	YES	YES	YES
How many genes are affected?	10,000 to 300,000+	10,000 to 300,000	Random and unknown, likely thousands	1 to 3
Do we know which genes in the seed are affected?	NO	NO	NO	YES
Research and development time?	5 to 30 years	5 to 30 years	5+ years	5 to 10 years
Tested by regulatory agencies to ensure safety for people, animals and the environment?	NO	NO	NO	YES
Can the seeds be patented?	YES	YES	YES	YES
Approved for non-GMO and organic farming?	YES	YES	YES	NO
Are people asking for labeling?	NO	NO	NO	YES

THIS CHART COMPARES AND CONTRASTS MODERN METHODS OF SEED IMPROVEMENT.

How do we create new and improved varieties of plants? It starts with the seed. Plant breeders and scientists work together to create new varieties to address evolving challenges to farming and changing consumer preferences. Humans have been central in seed improvement for over 10,000 years, and in the last 100 years our understanding of genetics has accelerated and enabled new seed improvement techniques. Compared to earlier methods, breeders can now make improvements to seeds by moving more precisely one or a few genes into a seed.

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Sourced by Dr. Kevin M. Folta, Professor and Chairman, Horticulture Sciences Department, University of Florida, GMOAnswers.com and Scitable by Nature Education.
Visit GMOAnswers.com for more information.

Why GMO?

Insect resistance	**Season-long protection against target pests, reduces the need for pesticide applications, and lowers input costs.**
Drought resistance	Ability to grow in much drier areas, conserving water and other environmental resources.
Herbicide tolerance	Fight weeds by applying herbicides only when needed and enabling farmers to use no-till production methods that preserve topsoil, prevent erosion, and reduce carbon emissions.
Disease resistance	With GM, the Hawaiian papaya industry was able to recover from the devastating papaya ringspot virus that had crippled the industry.
Enhanced nutritional profile	High-oleic soybeans have been genetically modified to produce oil with more monounsaturated fat, less saturated fat and little-to-no trans fat. Other GM crops are still being developed for nutritional improvement, including Golden Rice, which includes β-Carotene that could deliver vitamin A to children in developing nations.

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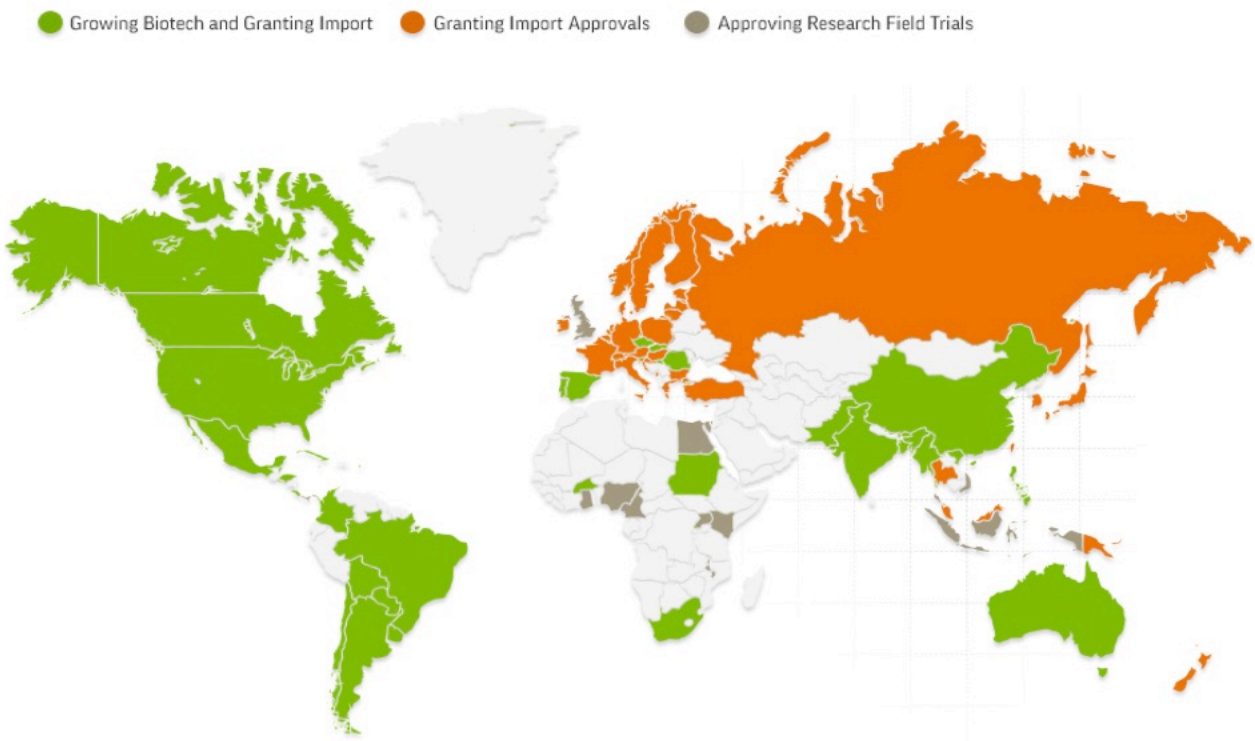
Who grows GMOs?

AS OF **2014**, GMOS ARE **GROWN, IMPORTED,** AND/OR USED IN **FIELD TRIALS** IN **70 COUNTRIES.**



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GET TO KNOW GMO BASICS

How do we ensure that GMOs are safe for use and consumption?

- GMO crops are studied extensively to make sure they are safe for people, animals and the environment
- GM seeds take an average of $136 million and 13 years to bring to market because of research, testing and regulatory approvals conducted by government agencies in the United States and around the world.[1]

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1 McDougall,P. (2011). The Cost and Time Involved in the Discovery, Development and Authorization of a New Plant Biotechnology Derived Trait

GET TO KNOW GMO BASICS

GMO Safety: Safe to Eat

- GMOs available today are *as safe as* their non-GMO counterparts.
- They do not cause new allergies, cancer, infertility, ADHD, autism or any other diseases or conditions.
- The safety of GMOs has been affirmed by:

NATIONAL ACADEMY OF SCIENCES

F A O FIAT PANIS

World Health Organization

AMA AMERICAN MEDICAL ASSOCIATION

AAAS ADVANCING SCIENCE, SERVING SOCIETY

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GMO Safety: Safe for the environment

Biotech crops have reduced agriculture's environmental footprint:

- Increased yield on current land prevents further deforestation and protects ecosystems
- Fewer pesticide applications
- No/reduced tillage with GM HT technology means less tractor fuel consumption and emissions

"In 2013, the permanent CO2 savings from reduced fuel use associated with GM crops was 62 billion pounds. This is equivalent to removing 12.4 million cars from the road for a year."

– Graham Brookes, Agricultural Economist, PG Economics Ltd

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GET TO KNOW
GMO BASICS

GMO Safety: Safe to Grow

When testing, researchers look for any difference between the GM and non-GM plants to make sure the GM variety grows the same as the non-GM variety.

They are also tested to make sure they do not unintentionally harm non-target, beneficial insects, like honey bees and ladybugs.

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Increased Crop Production

Between 1996 and 2013, Crop Biotechnology was Responsible for an Additional Global Production of:

21.7M

Metric Tons of Cotton Lint

274M

Metric Tons of Corn

138M

Metric Tons of Soybeans

Source: pgeconomics.co.uk

Economic Benefits

Economic gains of ~US$133 billion were generated globally by biotech crops between 1996 to 2013.

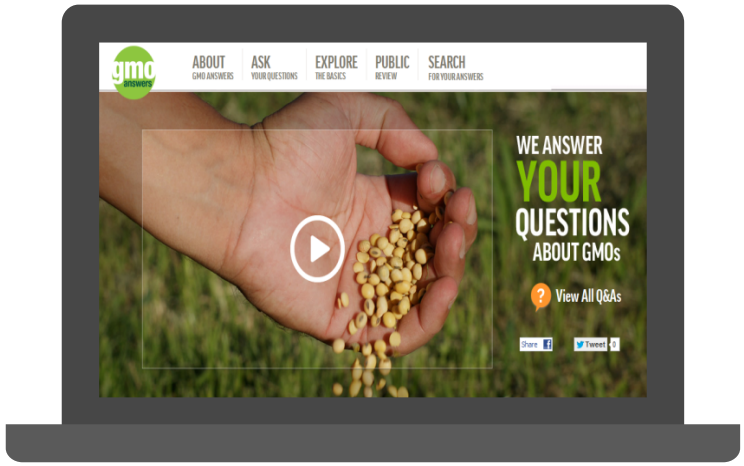
30% Due to reduced production costs

70% Due to substantial yield gains of **441.4 million tons**

Biotech cotton in developing countries has already made a significant contribution to the income of >16.5 million smallholder resource-poor farmers in 2013.

Source: pgeconomics.co.uk; ISAAA.org

Need More Background?



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Other GMO Resources:

- International Service for the Acquisition of Agri-Biotech Applications (ISAAA)
- Genetic Literacy Project
- BioFortified
- Grocery Manufacturers Association (GMAOnline)
- Biotechnology Industry Organization (BIO)
- Common Ground
- Food Insight from the International Food Information Council (IFIC)
- Science not Fiction

Thank You