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# Biotechnology and Genetically Modified Crops

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# Suggestions for Your Presentation

- Use a Video to start your presentation. A couple of videos were provided with this slide deck that could be used or use another that you have access to.
- Tell the stories about what happens on your farm. You are the expert and people love to hear what really goes on when you are growing their food
- Feel free to change these slides and/or add your own to tell the story that works for you
- Information in the “Notes” Section is for you to use as needed. It is not a script, but intended to be helpful during preparation for the talk.



# Biotechnology is Used in Many 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



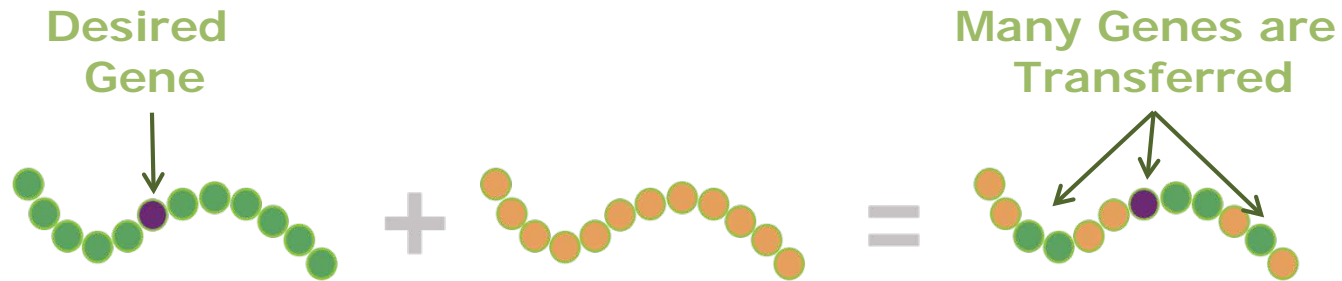
## Medicine

Most insulin used by diabetics is produced through biotechnology

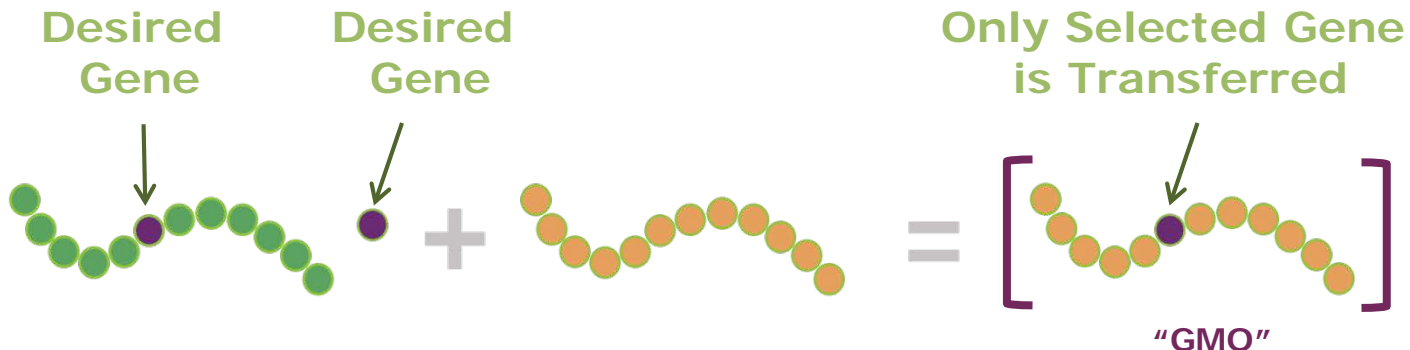


# Plant Biotechnology is an Extension of Traditional Plant Breeding

## Traditional Plant Breeding



## Plant Biotechnology



# Ways to have Better Harvests

GMOs are the product of a specific type of plant breeding where precise changes are made to a plant's DNA to give it characteristics that cannot be achieved through traditional plant breeding methods.



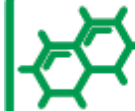
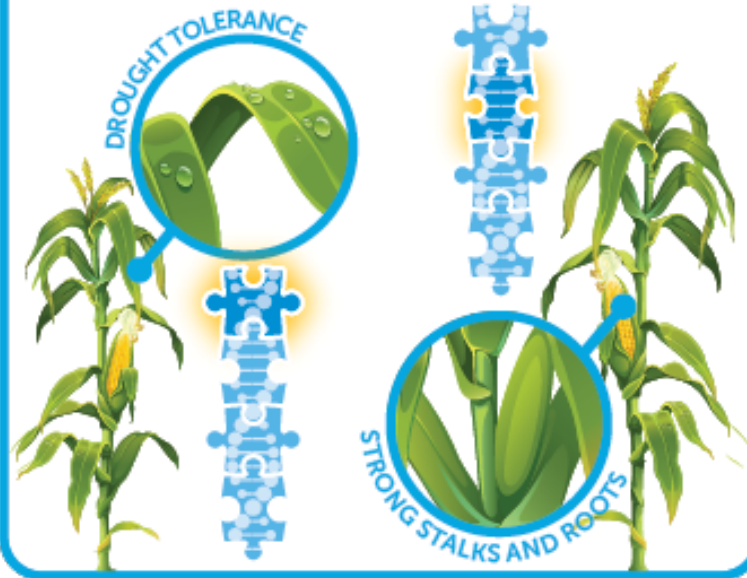
## SELECTIVE BREEDING

Plant breeders look for, select and cross-breed the best performing plants in the field, similar to how farmers have naturally improved the crops they grow since farming began.



## ADVANCED BREEDING

Breeders identify and tag desirable characteristics (traits) within a plant genome. They use this information to pick which plants to cross-breed and create better performing crops.



## GM PLANT BREEDING

If a plant needs a trait that can't be achieved through advanced breeding, a gene can be turned off or moved, or a gene from another source can be inserted.



### GMOs can help farmers ...





# What is a GMO?



<https://www.youtube.com/user/MonsantoCo/videos>



# The GMO Process

## Step 1: Trait Identification



### Fun fact:

For every one trait that is brought to market, more than 6,000 others are screened and tested.

Scientists conduct research to identify the specific genes responsible for beneficial traits that make crops resistant to disease, pests or drought.



# The GMO Process

## Step 2: Transformation



### Fun fact:

There are many ways to transform a cell. One common method uses agrobacterium - a natural bacterium that passes genes to plants.

Once the desired gene has been identified, scientists transfer the gene into a plant seed. The result is a genetically modified organism or GMO. Researchers can also turn off or move a gene within a plant to create a GMO.





# The GMO Process

## Step 3: Regulatory Science

Although the regulatory review process *begins* here, it will continue throughout the GMO process and carry on **through the life cycle of the product.**



### Safe to grow

- Crop exhibits expected characteristics (e.g., insect resistance)



### Safe for the environment and beneficial insects



### Safe to eat

- Same nutrients as non-GM crops
- No new dietary allergens



### Fun fact:

A new biotech seed product takes an average of 13 years and \$136 million in R&D before coming to market.<sup>2</sup>

More than 75 different studies are performed on each new biotech product before commercialization to ensure that they are safe for people, animals and the environment.<sup>1</sup>

<sup>1</sup> Source: <http://croplife.org/biotech-crop-development/>

<sup>2</sup> Source: <https://gmoanswers.com/sites/default/files/GMOA%2011x17%20Handout.pdf/>



# The GMO Process

## Step 4: Greenhouse Testing



### Fun fact:

Only after several years of **rigorous testing** are the top performing plants and traits selected to advance to field testing and *further* regulatory review.

After a GMO is developed in the lab, the seedlings are moved to greenhouses where further tests are performed.





# The GMO Process

## Step 5: Field Testing



### Fun fact:

More than **90 government bodies** in more than **60 countries** globally review and approve GMOs. In many countries, multiple agencies are involved in the regulation of GMOs.

Field trials are an important part of developing new products. They provide critical scientific and performance data.





# The GMO Process

## Step 6: Getting Seeds to Farmers



### Fun fact:

In 2016, more than **18 million farmers** globally chose to plant GMO seeds for better harvests, improved crop quality and the ability to use sustainable farming practices, such as no-till.

Farmers choose seeds that are best for their farms and businesses. Both GM and non-GM seeds are available options for farmers.



# There are Currently Ten Crops Commercially Available From GMO Seeds in the U.S.

## Genetic Traits

Expressed  
In GMOs In  
The U.S.

### RAINBOW PAPAYA

#### Genetic Traits

- Disease Resistance

#### Uses

- Table Fruit

### SUGAR BEETS

#### Genetic Traits

- Herbicide Tolerance

#### Uses

- Sugar,
- Animal feed

### SWEET CORN

#### Genetic Traits

- Insect Resistance

#### Uses

- Food

### FIELD CORN

#### Genetic Traits

- Insect Resistance
- Herbicide Tolerance
- Drought Resistance

#### Uses

- Livestock and poultry feed
- Fuel Ethanol
- High-fructose corn syrup and other sweeteners
- Corn oil
- Starch
- Cereal and other food ingredients
- Alcohol
- Industrial uses

### COTTON

#### Genetic Traits

- Insect Resistance
- Herbicide Tolerance

#### Uses

- Fiber,
- Animal feed
- Cottonseed oil

### SOYBEAN

#### Genetic Traits

- Insect Resistance
- Herbicide Tolerance

#### Uses

- Livestock and poultry feed
- Aquaculture
- Soybean oil
- High oleic acid
- Soymilk, soy sauce, tofu, other food uses
- Lecithin
- Pet food
- Adhesives and building materials
- Printing ink
- Other industrial uses

### POTATO

#### Genetic Traits

- Reduced Bruising and Black Spot, Non-browning, Low Acrylamide

#### Uses

- Food

### ALFALFA

#### Genetic Traits

- Herbicide Tolerance

#### Uses

- Animal feed

### CANOLA

#### Genetic Traits

- Herbicide Tolerance

#### Uses

- Cooking oil
- Animal feed

### SUMMER SQUASH

#### Genetic Traits

- Disease Resistance

#### Uses

- Food

Approved and Coming  
to Market Soon

### APPLE

#### Genetic Traits

- Non-browning,

#### Uses

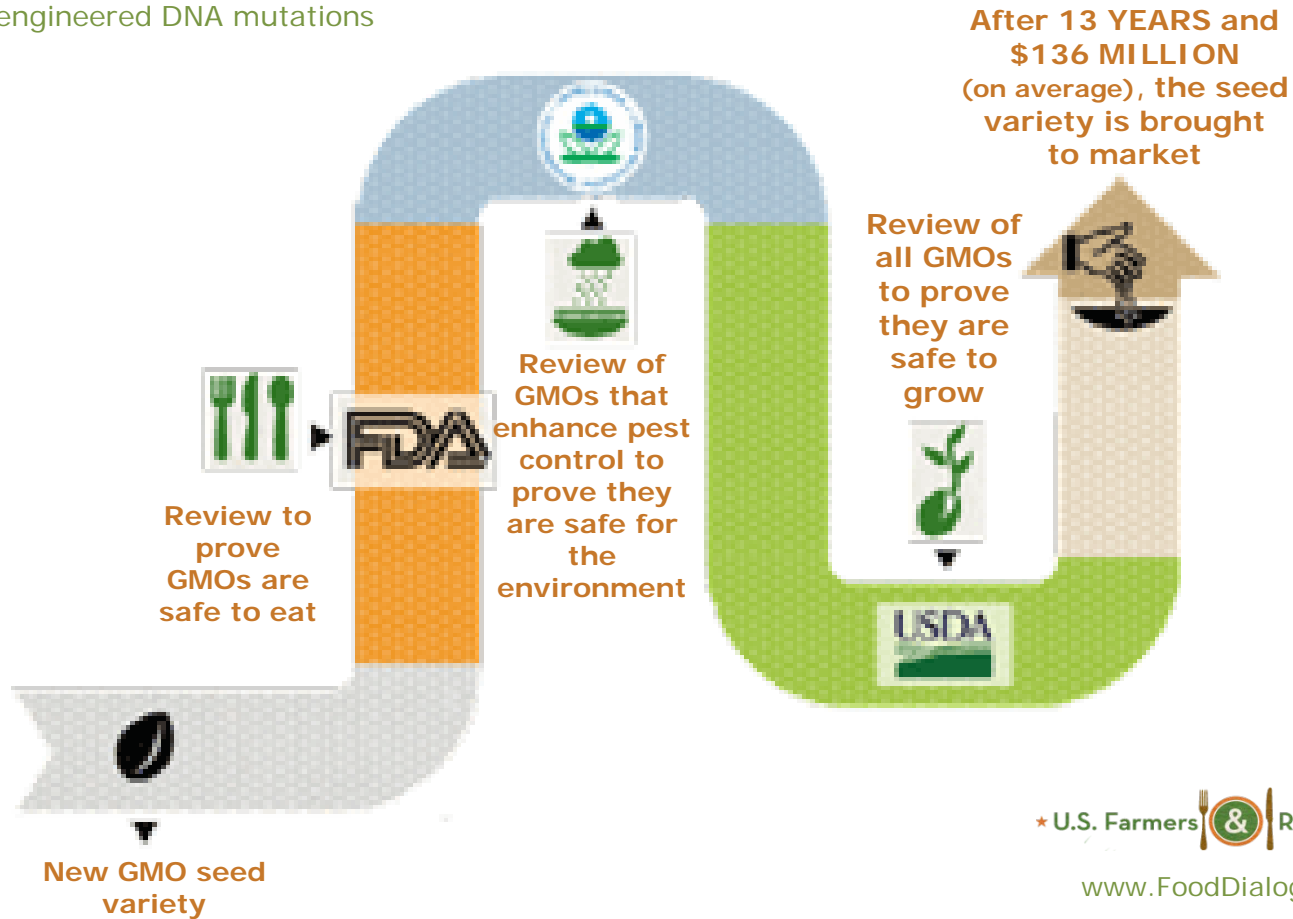
- Food



# How a GM Seed Gets to Market

No other type of new seed that comes to the market from other breeding methods goes through pre-market regulatory approval, including the thousands of conventional and organic seeds developed from mutagenesis\*. Only GMOs are required to be reviewed. Even before the new seed goes through the review process, years of testing and research take place.

\*Deliberately engineered DNA mutations



\* U.S. Farmers & Ranchers Alliance \*

[www.FoodDialogues.com](http://www.FoodDialogues.com)





# Genetically Modified Crops (GMOs)

Produce Food that is Safe and Nutritious

**5.3 billion acres** of farmland used for GMO crops since 1996

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**35+ years** that GMO crops have been researched and developed

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**67 countries** where GM crops have been found safe for growing or import

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# The Benefits of GMOs

## Some Examples of the Benefits of GMOs

**CORN** that is tolerant to drought, insects and disease

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**SOY** that can be planted without tilling, preserving precious topsoil

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**COTTON** that is protected from harmful insects

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**PAPAYA** that resists a disease that threatened to wipe out the crop



DISEASE  
TOLERANCE



DROUGHT  
TOLERANCE



INSECT  
RESISTANCE



HERBICIDE  
TOLERANCE





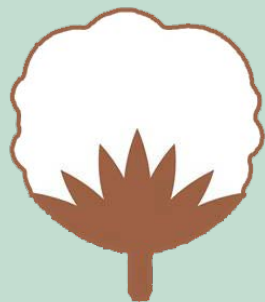


# Better Harvests

Between 1996 and 2015, Crop Biotechnology was Responsible for an Additional:

29M

Metric Tons  
of Cotton  
Lint



199M

Metric Tons  
of Soybeans



394M

Metric Tons  
of Corn



# Economic Benefits

Economic gains of ~U.S. \$168B were generated globally by biotech crops between 1996 to 2015.



**30%** Due to reduced production costs

**70%** Due to substantial yield gains of **634M tons**

Biotech cotton in developing countries has already made a significant contribution to the income of **>16.5 million** smallholder resource-poor farmers in 2015



# Environmental Benefits

The reduction in pesticides from 1996 to 2015 was estimated at **619 million kilograms or 8.1% reduction**

In 2014 alone, biotech helped prevent an estimated **26.7 billion kg of CO<sub>2</sub> emissions**, equivalent to removing ~ **12 million cars** from the road for a year.

Without biotech, it would take an additional **48.1 million acres** to produce the same amount of food produced in 2015.



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# GMO Safety

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# GM Crop Safety

GM crops are reviewed by hundreds of independent risk assessors and scientists.

Every credible U.S. and international food safety authority that has studied GM crops has found that they are safe.

No health effects attributable to their use have been found.

Since 1994 **more than 60 different** countries have granted more than **3,800 commercial use approvals** on **477 different GM traits in 29 crops.**

In many countries there are multiple regulatory authorities (up to seven in one country) with the responsibility of assessing a particular aspect of safety.



# In the U.S., Three Regulatory Agencies have Oversight for GM Crops



Is it safe for the environment?



Is it safe for humans and animals to eat?

- Nutritional changes
- Compositional changes



Is it safe for humans and the environment?

Globally, >30 additional regulatory bodies also review each product before it can be commercialized.



# GMO Research, Review and Regulation

On average, GMOs take **13 years** and **\$130 million** of R&D **BEFORE** coming to market

The **regulatory process** alone can take **5 to 7 years**

## REGULATORY SCIENCE

**75+ different studies<sup>1</sup>** are conducted to demonstrate each new GMO is:



### Safe to grow

- Crop grows the same as non-GM varieties
- Crop exhibits expected characteristics (e.g., insect resistance)



### Safe for the environment and beneficial insects



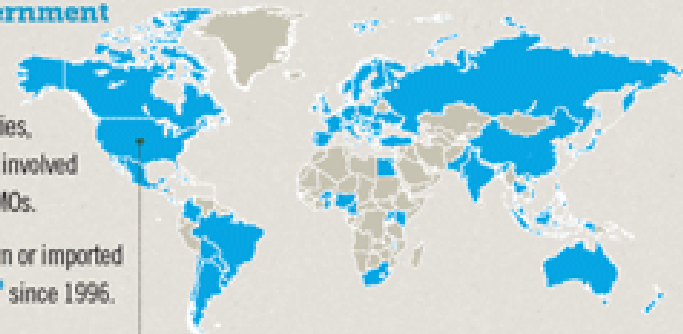
### Safe to eat

- Same nutrients as non-GM crops
- No new dietary allergens



## REGULATORY REVIEW

More than **90 government bodies<sup>2</sup>** globally review and approve GMOs. In many countries, multiple agencies are involved in the regulation of GMOs.



GMOs have been grown or imported by **70 countries<sup>3</sup>** since 1996.

### U.S. REGULATORY AGENCY REVIEWS



Safe to grow



Safe for the environment



Safe to eat



<sup>1</sup>Estimated numbers from DuPont Pioneer based on studies from recent biotech applications. <sup>2</sup>Includes agencies reviewing new biotechnology applications from 62 individual countries and 28 EU member countries. <sup>3</sup>Country count cited from ISAAA.org

For more information, visit [www.GMOAnswers.com](http://www.GMOAnswers.com)





# Expert Scientific Findings

## U.S. Food and Drug Administration

"Food and food ingredients derived from GE plants must adhere to the same safety requirements ... that apply to food and food ingredients derived from traditionally bred plants. The consultation is complete only when FDA's team of scientists are satisfied with the [GE Food] developer's safety assessment and have no further questions regarding safety or other regulatory issues."

May 2013

## United States National Academy of Sciences

The study committee found "no substantiated evidence of a difference in risks to human health between currently commercially genetically engineered (GE) crops and conventionally bred crops, nor did it find conclusive cause-and-effect evidence of environmental problems from the GE crops."

May 2016

## American Medical Association Council on Science and Public Health

"Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."

June 2012





# Expert Scientific Findings

## American Council on Science and Health

"It's irresponsible to assert that GMOs pose any dangers to consumers or the environment since billions of tons of crops have been produced using GMO technology and harvested over many years, and still not a single case of adverse health or environmental effects from such farming practices have been documented."

February 2013

## Anne Glover Former European Commission Chief Scientific Advisor

"If we look at evidence from 15 years of growing and consuming GMO foods globally, then there is no substantiated case of any adverse impact on human health, animal health or environmental health, so that's pretty robust evidence, and I would be confident in saying that there is no more risk in eating GMO food than eating conventionally farmed food."

July 2012





# Expert Scientific Findings

## European Academies Science Advisory Council

"The production of more food, more sustainably, requires the development of crops that can make better use of limited resources .... Sustainable agricultural production and food security must harness the potential of biotechnology in all its facets."

June 2013

## American Association for the Advancement of Science

"The science is quite clear: Crop improvement by the modern molecular techniques of biotechnology is safe."

October 2012

## And Bill Gates Business Leader, Entrepreneur, Philanthropist

"The world faces a choice, by spending a relatively little amount of money on proven solutions, we can help poor farmers feed themselves and their families and continue writing the story of a steadily more equitable world. Or we can decide to tolerate a very different world in which one in seven people needlessly lives on the edge of starvation."

January 2012





# More Information is Available at GMOAnswers.com



GMOs have played an important role in agriculture for over 20 years and continues to be a safe and precise tool that is improving the way food is grown.

