

# Genetically Engineered Crops: What Are They, Why the Consumer Push-back?

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College of Agriculture and Life Sciences

Credit: Civil Beat cartoonist John Pritchett

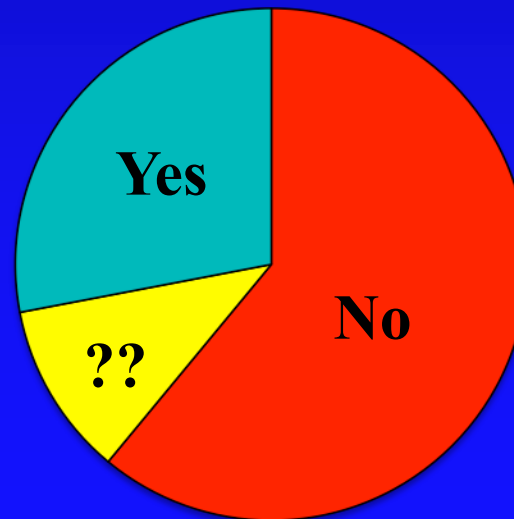
# Topics

- Why the controversy?
- What is genetic engineering?
  - Context – previous crop genetic change
- What GE crops are out there?
- Consumer concerns...



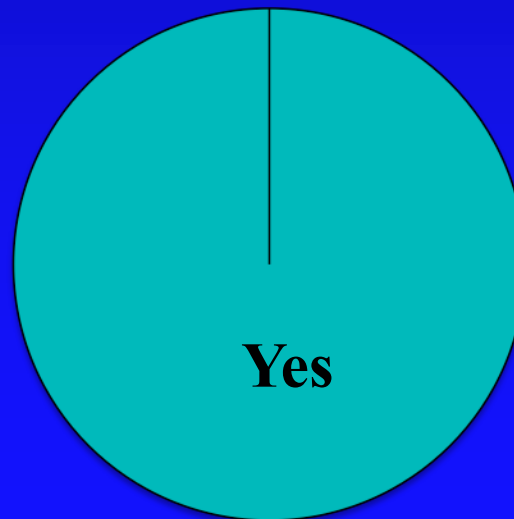
# Why the Controversy?

- Genetic engineering - a logical extension of what plant breeders have always done
  - Little understanding of plant breeding
  - Have you ever eaten a fruit or vegetable that is a product of “traditional cross breeding”?



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  - Have you ever eaten a fruit or vegetable that is a product of “traditional cross breeding”?
- What benefits to consumers??
- New technology always raises concerns...





# Genetic Engineering

- A new tool for breeding improved crops

Art credit:  
Giovanni Stanchi,  
1645-1672

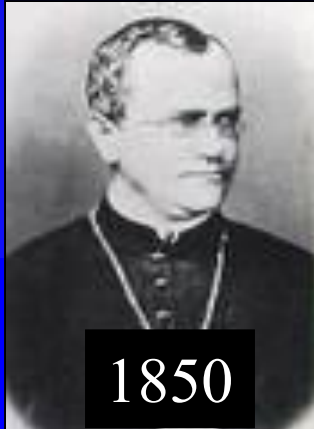


The watermelon, then and now. (Christie Images LTD 2015, Shutterstock)

Comparison:  
James Nienhuis,  
Univ. Wisconsin



9000 yr. ago



1850



1929



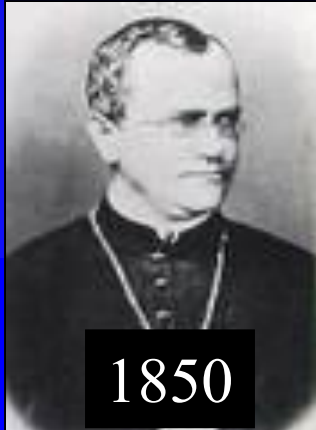
2000



www.bio-equip.cn

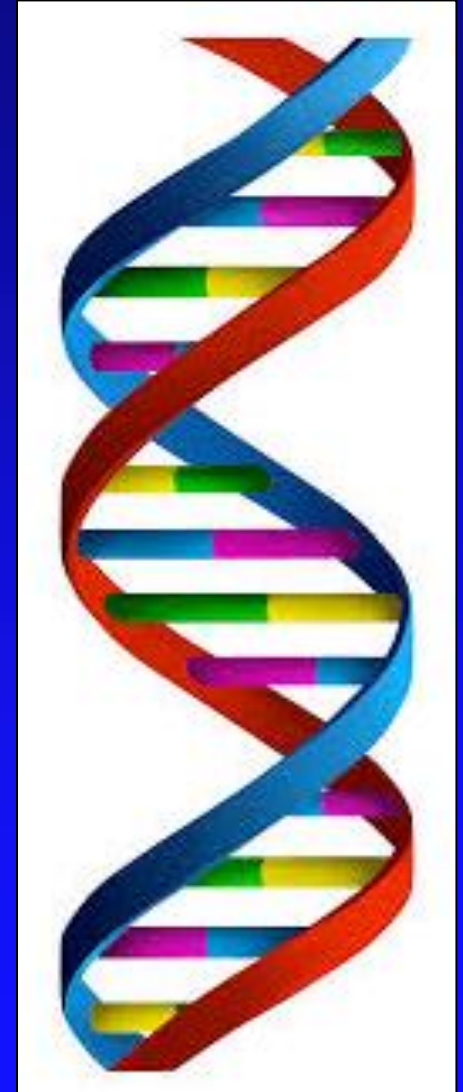
# Genetic Engineering

- A **new** tool for breeding improved crops
- Alters the properties of organisms by:
  - Moving single genes between organisms
  - Modifying a gene within an organism
- No need for sexual cross-compatibility...



# About Genetic Material...

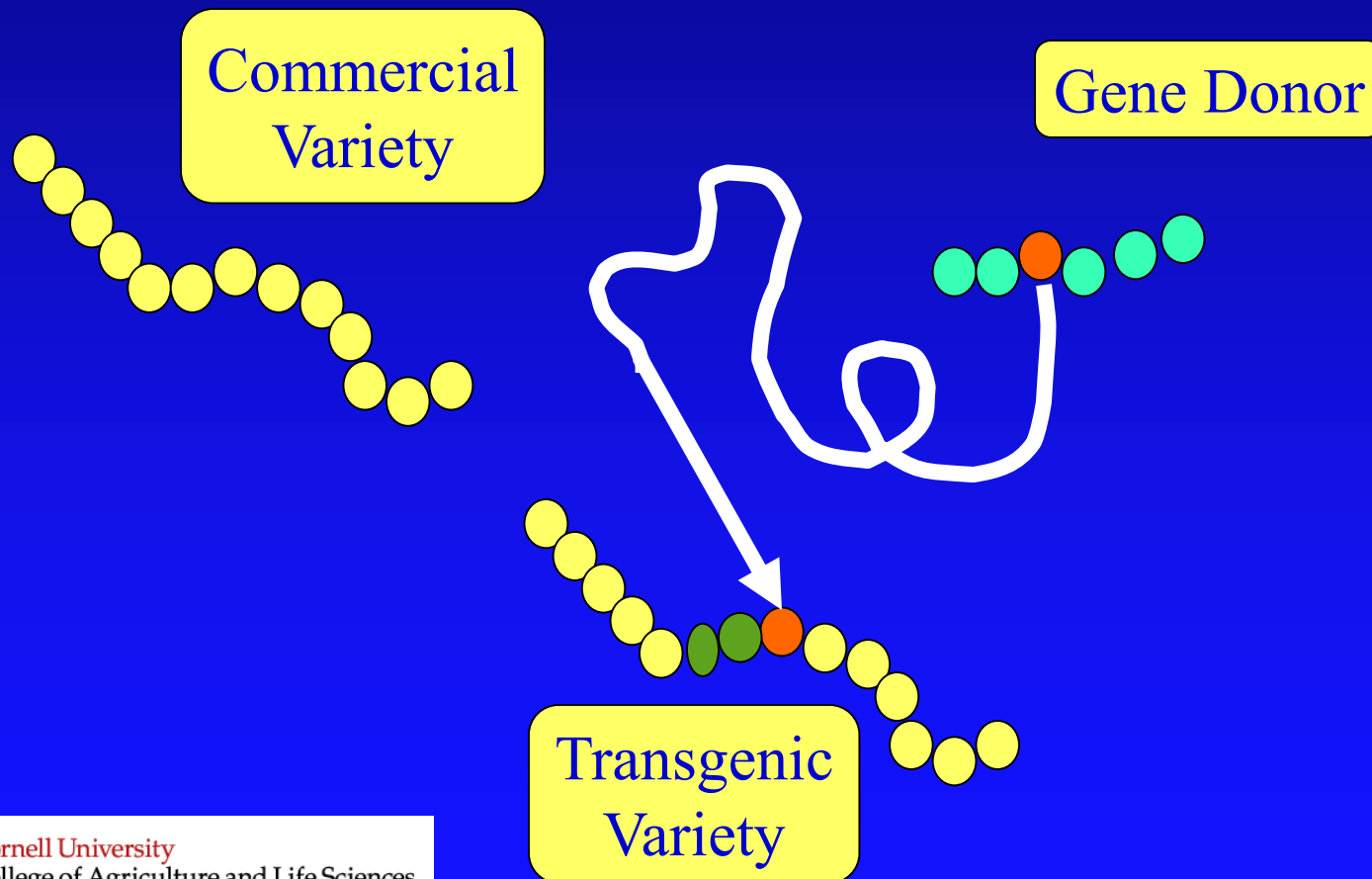
- Deoxyribonucleic acid (DNA)
  - The “code book” for an organism
    - Structural products
    - Enzymes
    - “Air traffic control”
- An alphabet of four “letters”
- Universal





# Genetic Engineering

Adds one or a few genes to a particular parent



# Genetic Modifications Humans Have Made...

- Domestication
- Farmer selection of new crops and varieties
- Cross breeding
- Genetic engineering



# GE Crop Types Grown in the US

- Bt crops (corn, cotton, sweet corn)
- Herbicide resistant crops (soybean, corn, cotton, canola, sugar beet, alfalfa)
- Virus resistant crops (papaya, squash)



# Recently Approved GE Varieties

- Soybean – insect resistant (2014)
- Soybean, corn, cotton – new herbicide tolerances (11 in 2014-2016)
- Creeping bentgrass – glyphosate resistant (2017)



- Alfalfa – reduced lignin (2014)
- Potato – less black spot bruise, low acrylamide production, late blight resistant (4 in 2014-2016)
- Apple – non-browning (1 each in 2015 and 2016)





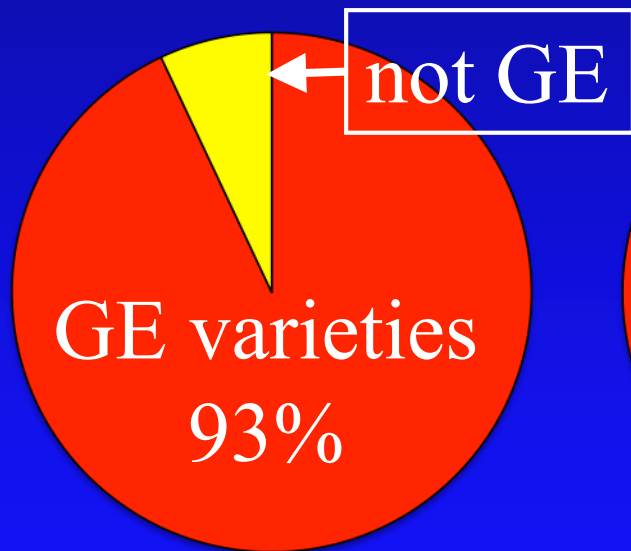
# Issues and Concerns

- Extent of use
- Environmental impacts
- Food safety, allergens
- Right to know, labeling
- Consolidation in ag industries and profits
- Belief systems (ethical, religious)

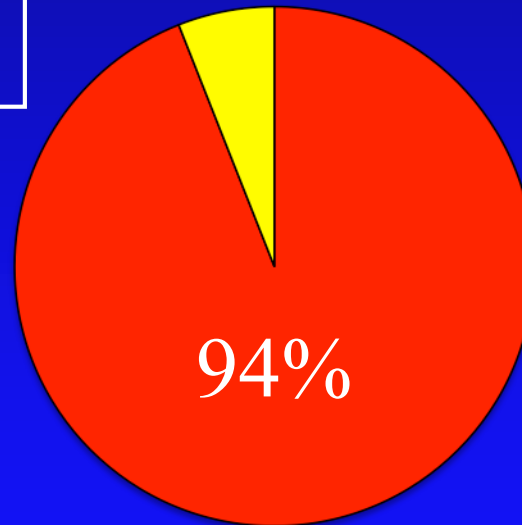


# Percentage U.S. Crop Acreage Planted to GE Varieties, 2016

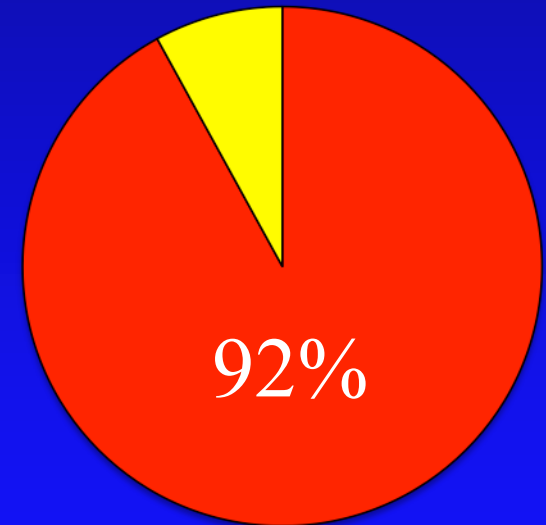
## Cotton



## Soybean

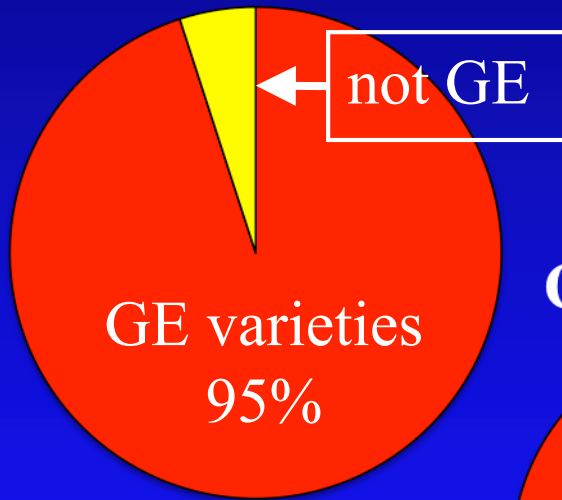


## Field Corn

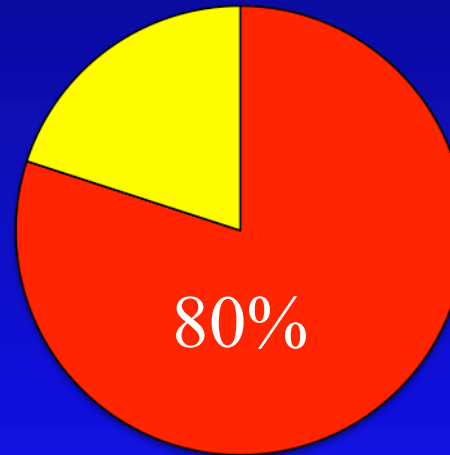


# Estimates: U.S. Crop Acreage Planted to GE Varieties

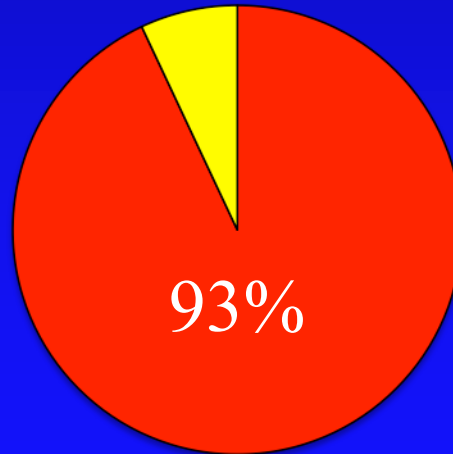
Sugarbeet (2013)



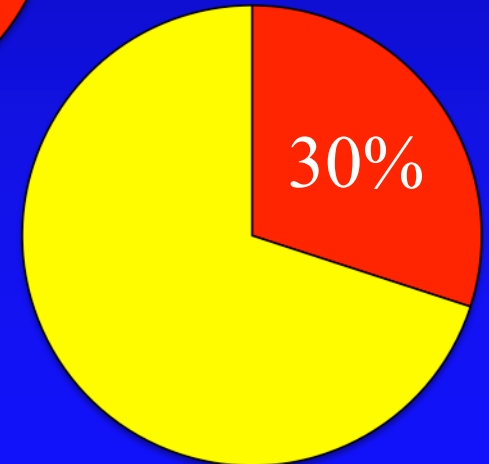
Papaya (2014)



Canola (2013)

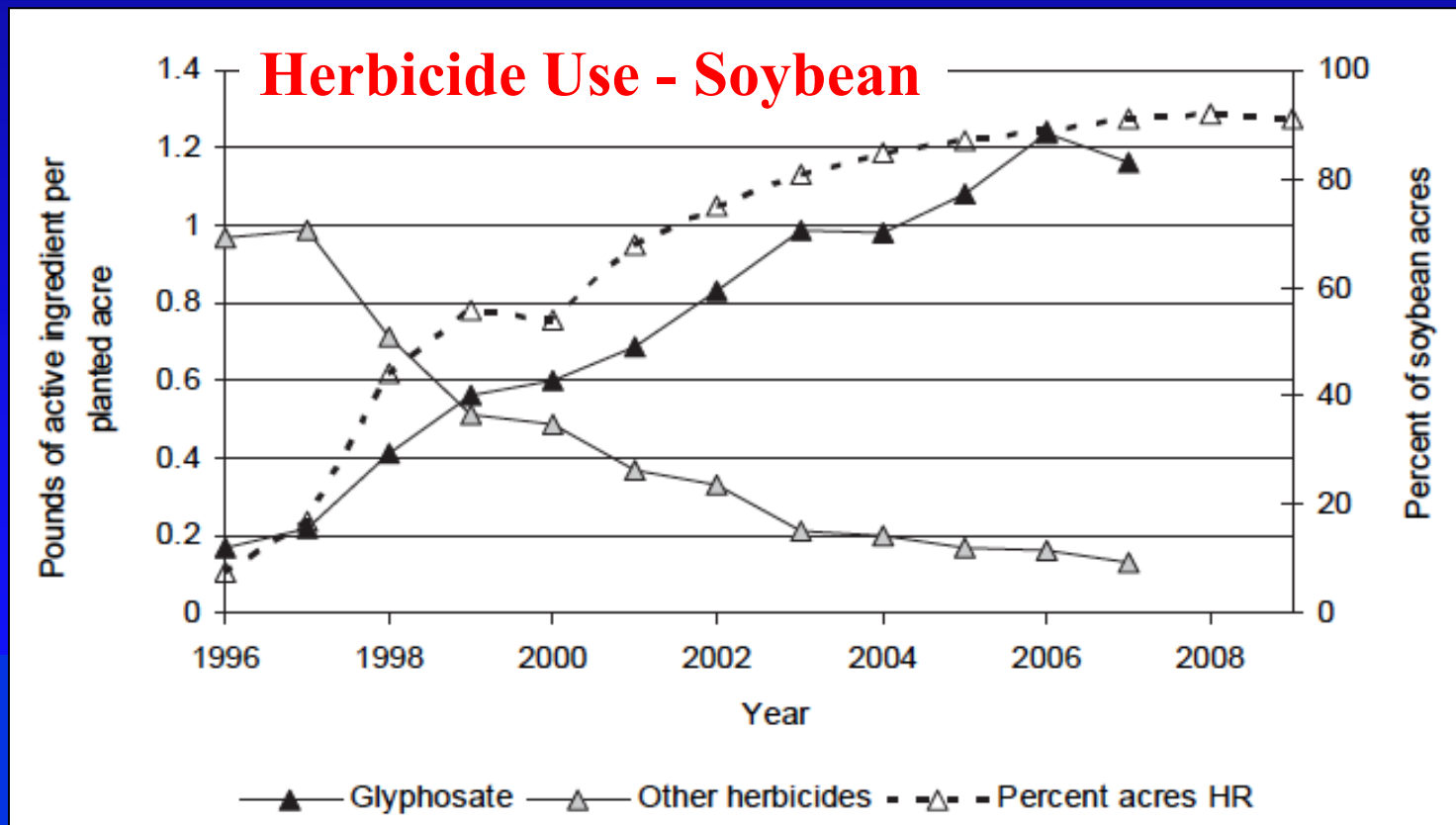


Alfalfa (2013)



# U.S. Herbicide Use per Acre

- More herbicide used
- Major shift from more to less toxic types
- Facilitated use of reduced tillage



Source:  
NRC NAS  
2010



# Weed Resistance to glyphosate



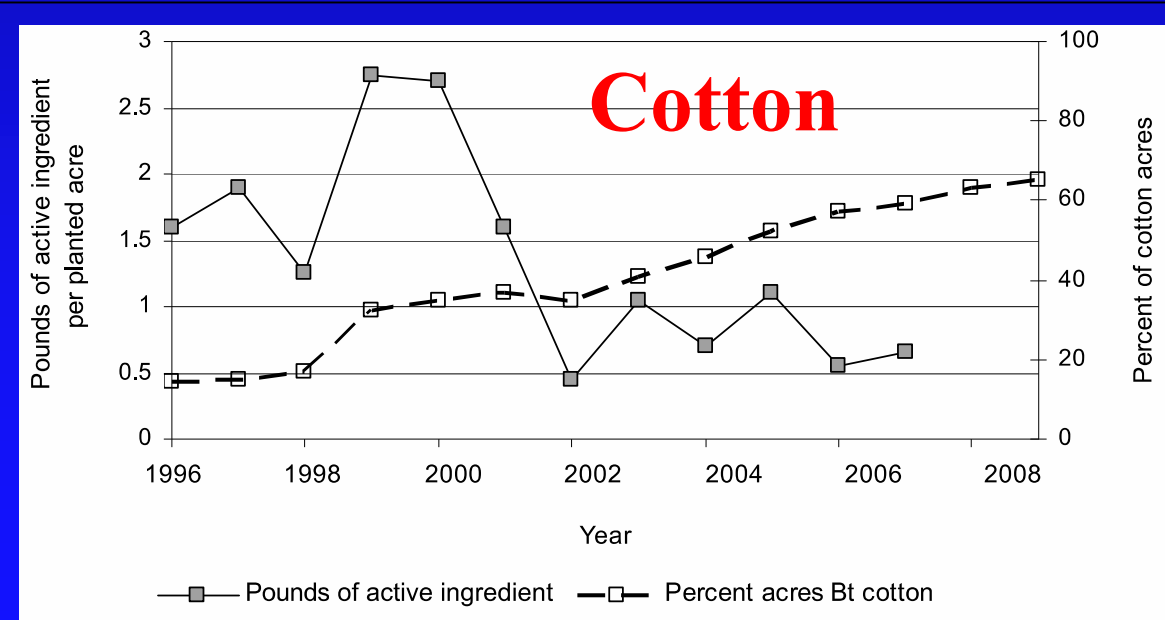
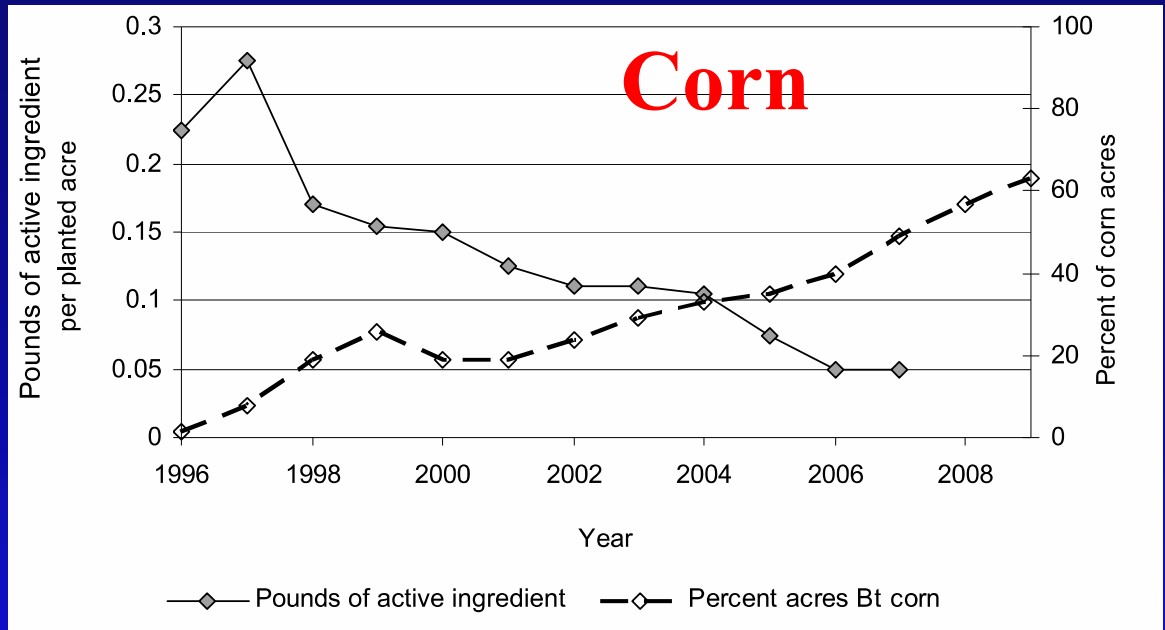
Glyphosate Resistant Giant Ragweed (*Ambrosia trifida*) infesting Roundup Ready Corn. Photo: Dr. Bill Johnson



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# U.S. Insecticide Use per Acre is Down

Source:  
NRC NAS 2010



# Bt Corn Rootworm Trait

- A very “plastic” insect species
- Has evolved resistance to:
  - Insecticides
  - Rotations
- Now also to Bt...





# NAS – NRC Study Findings

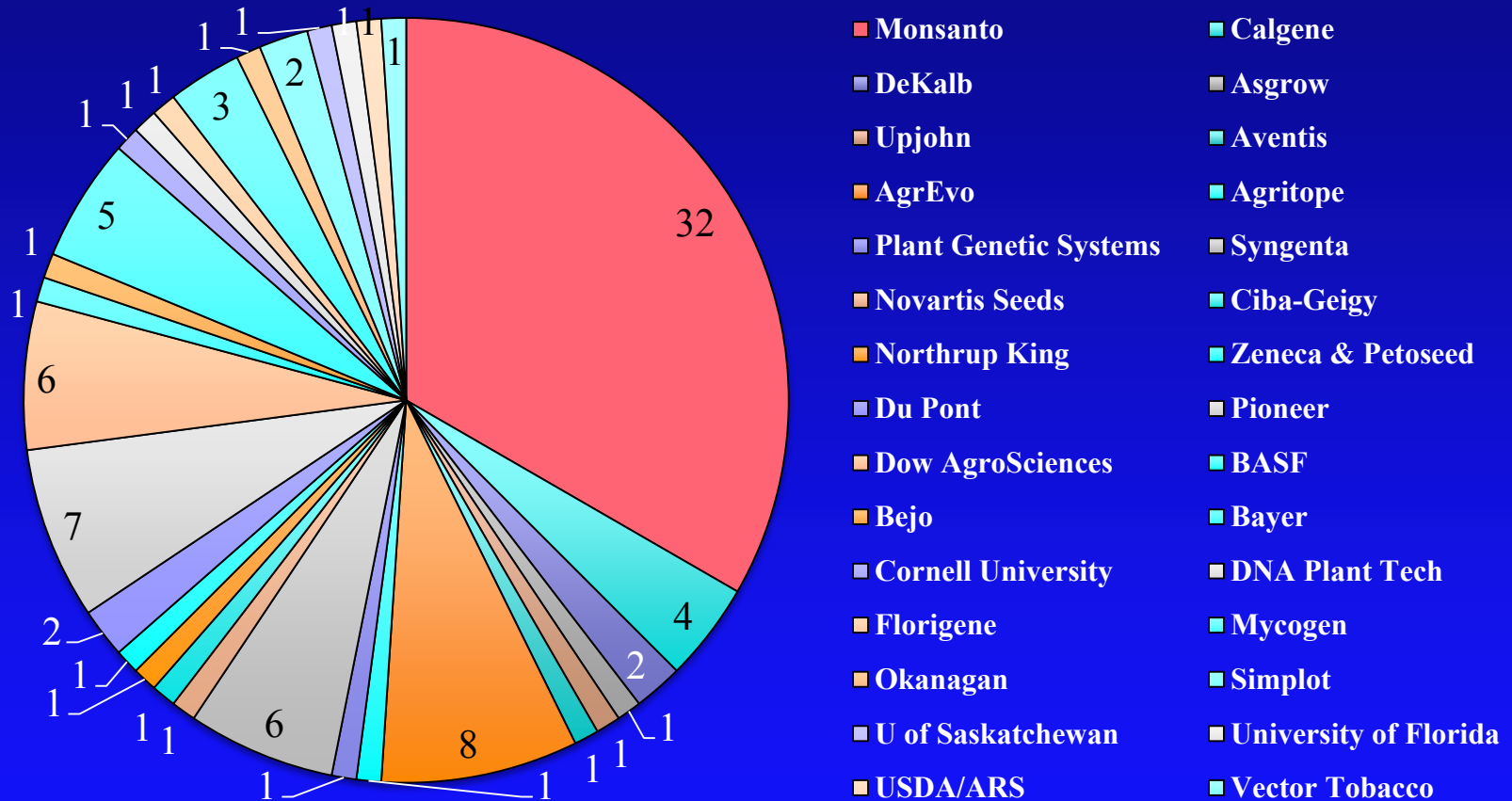
- More herbicide used, but a less toxic one
  - Facilitated use of reduced tillage
- Less insecticide use
- Gene flow not a concern to date
- Many farmers benefited economically, in worker safety, and in convenience
- Effects on prices, non-GE producers, social impacts not fully understood
- Need more study of market concentration





# Who Owns GE Traits? - originally

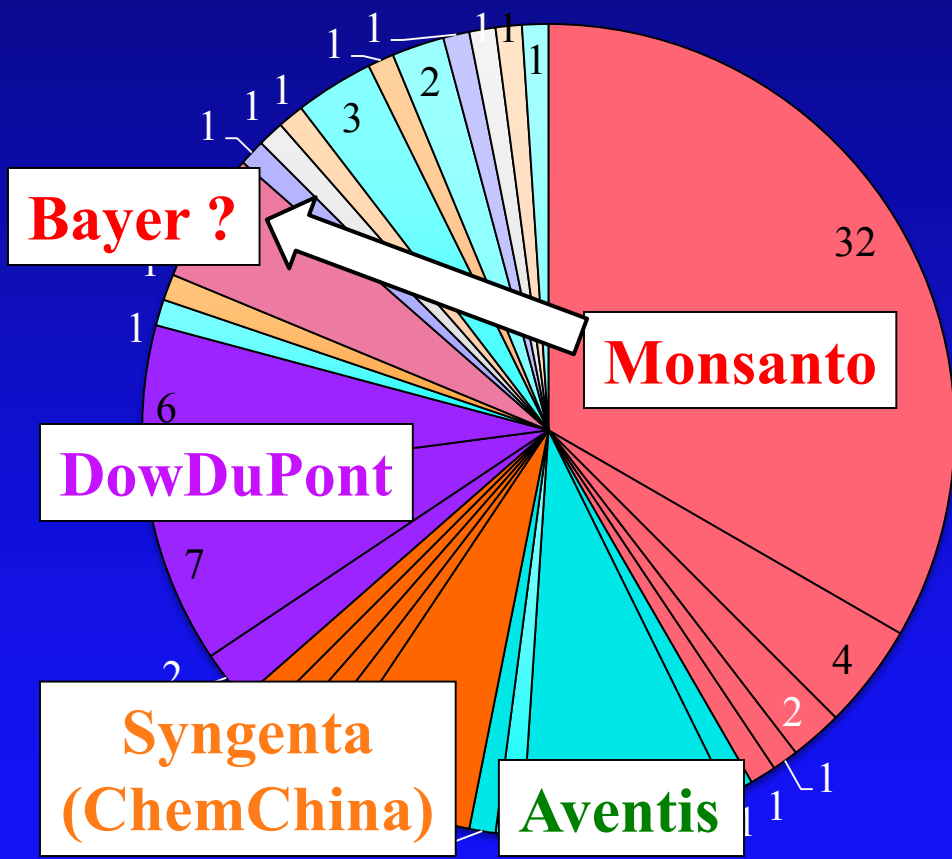
Total = 96



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# Who Owns GE Traits? – now...

Total = 96



- Monsanto
- DeKalb
- Upjohn
- AgrEvo
- Plant Genetic Systems
- Novartis Seeds
- Northrup King
- Du Pont
- Dow AgroSciences
- Bejo
- Cornell University
- Florigene
- Okanagan
- U of Saskatchewan
- USDA/ARS
- Calgene
- Asgrow
- Aventis
- Agritope
- Syngenta
- Ciba-Geigy
- Zeneca & Petoseed
- Pioneer
- BASF
- Bayer
- DNA Plant Tech
- Mycogen
- Simplot
- University of Florida
- Vector Tobacco



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**Am I eating  
foods from genetically  
engineered crops?**



**Are they safe?**



**How do they benefit me??**

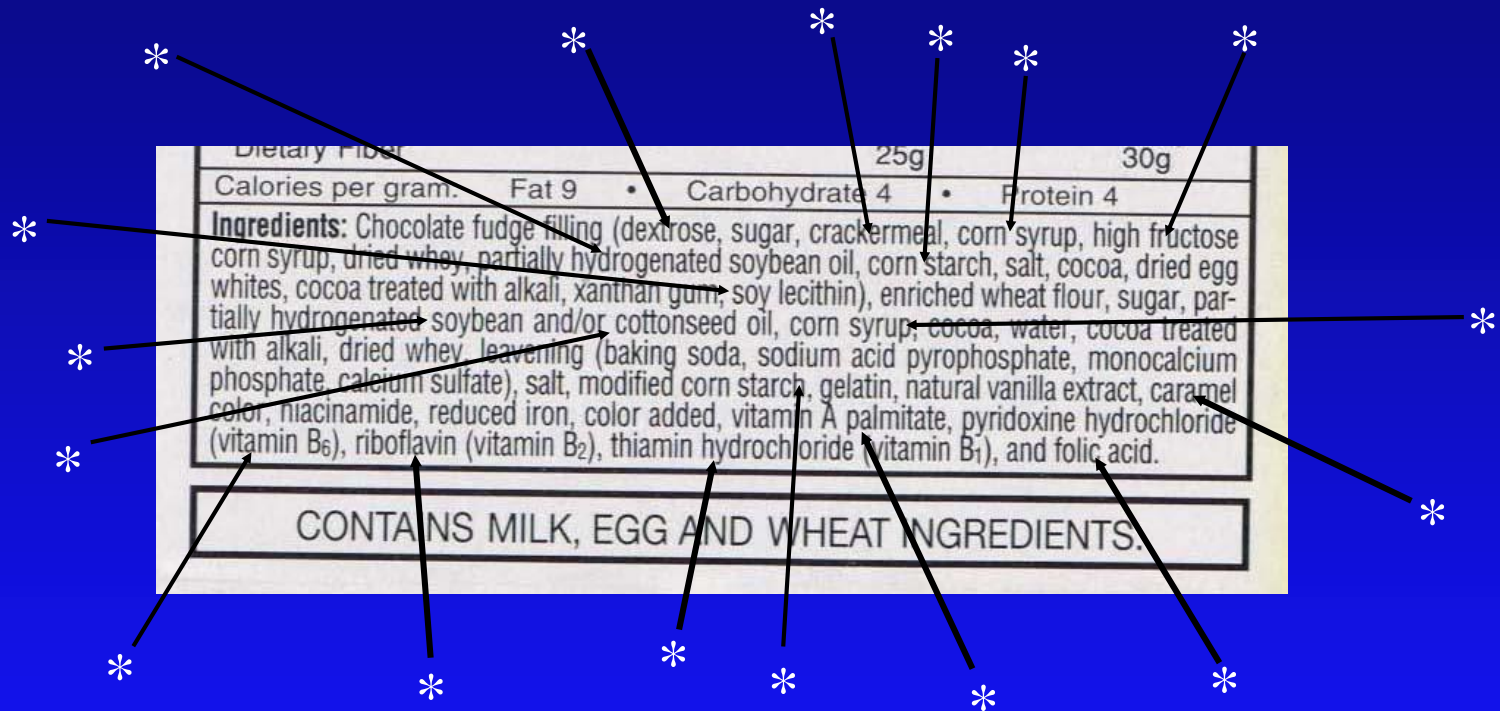


# What foods contain GE crops?

- 60-70% of supermarket foods have ingredients from a GE variety
- Products made with soy or corn most obvious
- Products with soy or corn derivatives
- Limited fresh produce



# Food for Thought



\* Ingredient may be made from a genetically-engineered organism





# The Food Supply

GE Crops

Non-GE Crops

Harvesting  
Equip. & Trucks

Whole Foods  
& Grain

Refined  
Ingredients

Derivatives

Fresh Market  
Produce  
(corn, tomatoes...)

Processed Foods  
(syrops, flours, oils)

Nutrients &  
Vitamins  
(Vitamins C, E...)

Detection

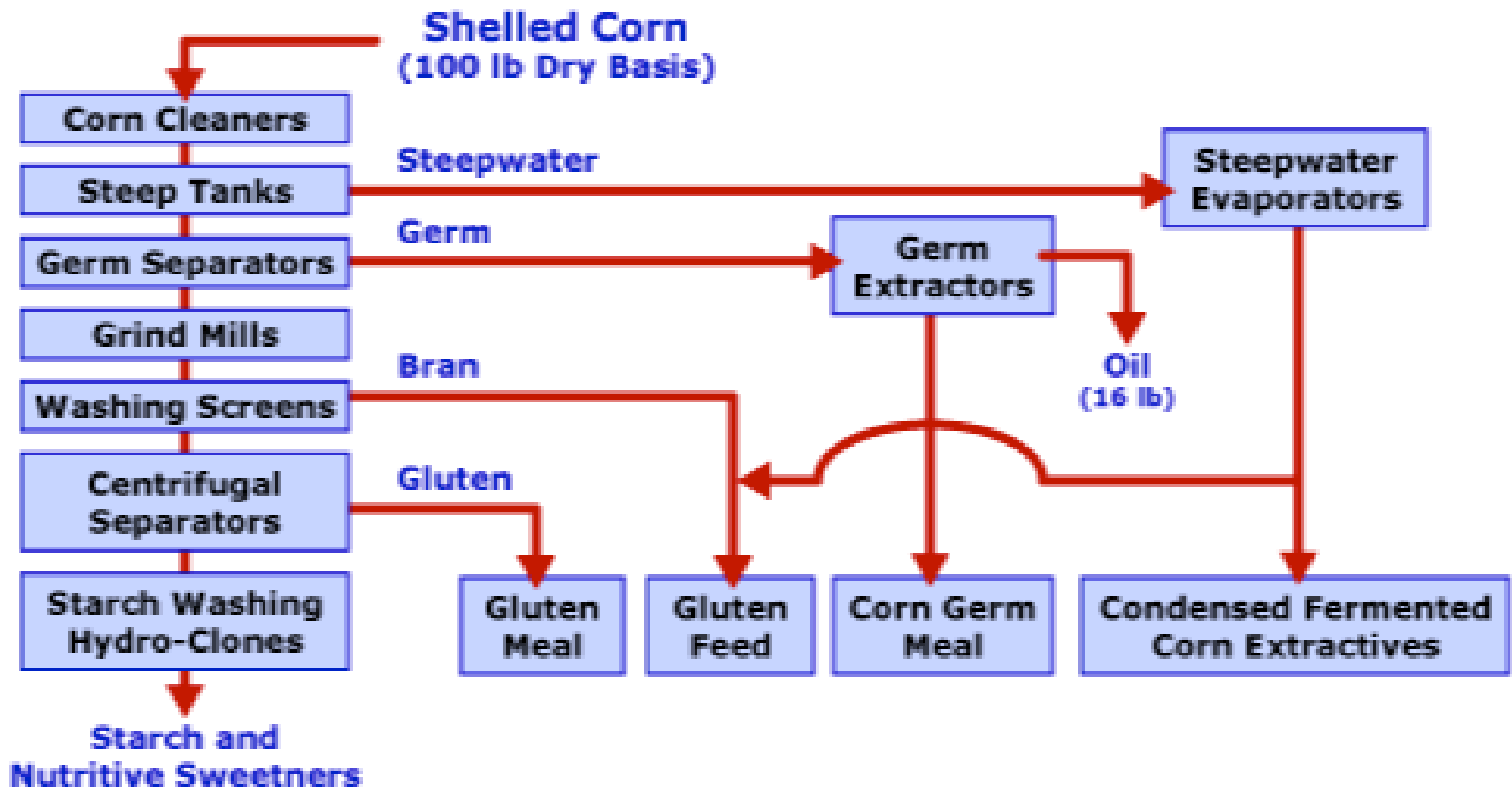
DNA

Protein



# Corn Wet Milling

## Steps in the Wet Corn Milling Process



# Case in point: Original Cheerios



**Ingredients:** Whole Grain Oats (includes the oat bran), Modified Corn Starch, Sugar, Salt, Tripotassium Phosphate, Wheat Starch. Vitamin E (mixed tocopherols) Added to Preserve Freshness.

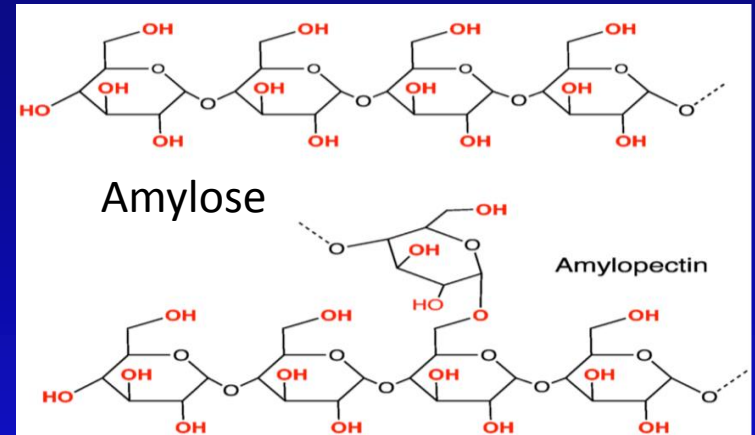
**Vitamins and Minerals:** Calcium Carbonate, Iron and Zinc (mineral nutrients), Vitamin C (sodium ascorbate), A B Vitamin (niacinamide), Vitamin B<sub>6</sub> (pyridoxine hydrochloride), Vitamin A (palmitate), Vitamin B<sub>2</sub> (riboflavin), Vitamin B<sub>1</sub> (thiamin mononitrate), A B Vitamin (folic acid), Vitamin B<sub>12</sub>, Vitamin D<sub>3</sub>.

Which ingredients could come from GE varieties?



# What is corn starch?

- Mixture of amylose and amylopectin
  - Chains of glucose
- No DNA, no protein



# What is beet (or cane) sugar?

- Sucrose
- No DNA, no protein





# Are the new Cheerios different?

## WHY THEY'RE SO GOOD

- 12 Vitamins & Minerals
- Low Fat
- Good source of calcium
- Good source of fiber
- Made with whole grain\*
- May reduce the risk of heart disease
- Can help lower cholesterol\*\*
- 1g sugar
- Excellent source of iron
- Not made with genetically modified ingredients\*\*\*



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# Are GE Crop Products Safe?

- Genetic Engineering Risk Atlas
  - 400+ studies, half were independently-funded
  - <http://genera.biofortified.org/viewall.php>
- 2014 summary of 1,783 studies
  - Safety as food, feed (770 studies)
  - Environmental impacts (847 studies)
- No credible evidence of safety concerns



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**GENERA**

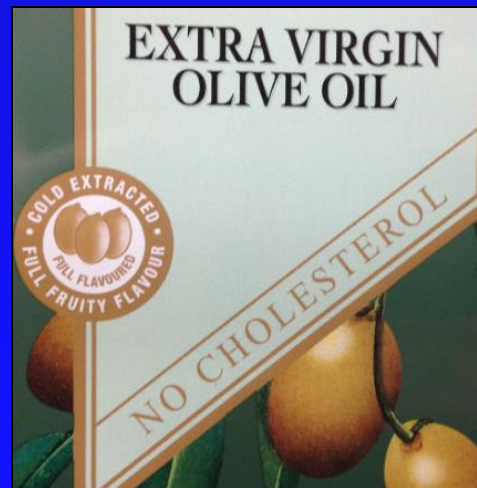
GENetic Engineering Risk Atlas

A project of  
Biology Fortified, Inc.



# What about labeling?

- Activism both for and against
- Two kinds of food labeling:
  - Product-based (i.e., ingredients)
  - Process-based (i.e., how it was made)
- FDA labeling guidance says it must be:
  - Truthful
  - Not misleading



No Trans Fatty Acids

Nutrition Facts		Amount/Serving	% DV*	Amount/Serving	% DV*
Total Fat	8g	12%	Cholest. 0mg	0%	
Sat. Fat	1g	5%	Sodium 110mg	5%	
Polyunsat. Fat	2g		Total Carb. 0g	0%	
Monounsat. Fat	4g		Protein 0g		
Calories 70		Vitamin A 10% • Vitamin E 20%			
Fat Cal. 70		Not a significant source of dietary fiber, sugars, vitamin C, calcium and iron.			

\* Percent Daily Values (DV) are based on a 2,000 calorie diet.

Ingredients: Liquid Canola Oil, Water, Plant Stanol Ester, Partially Hydrogenated Soybean Oil, Salt, Emulsifiers (Vegetable Mono- and Diglycerides, Soy Lecithin, Polyglycerol Esters of Fatty Acids), Hydrogenated Soybean Oil, Potassium Sorbate, Citric Acid and Calcium Disodium EDTA to Preserve Freshness, Artificial Flavor, dl- $\alpha$ -Tocopheryl Acetate, Vitamin A Palmitate. Colored with Beta Carotene.



# What about labeling?

## Do consumers want it??

- “Should GM food be required to be labeled?”
  - 73% say yes
- “What information would you like to see on food labels that is not already there?”
  - 7% bring up genetic engineering
- Not too many consumer questions at grocery stores, but inquiries at Wegman’s are up...





# 2016 Federal Labeling Law

- National Bioengineered Food Disclosure Standard
  - Safe and Accurate Food Labeling Act (SAFE Act)
  - Denying Americans the Right to Know Act (DARK Act)



# 2016 Federal Labeling Law

- USDA has 2 years to write the rules
  - “National mandatory bioengineered food disclosure standard”
  - Text, symbol, or electronic/digital link
- Not animals that consume GE feed
- Excludes restaurant food
- Prohibits state or local labeling requirements that differ from the federal requirement



# To avoid GE-derived content:

- Certified organic
- Non-GMO verified
- Voluntary labels
  - “We do not use ingredients that were produced using biotechnology”
  - “This oil is made from soybeans that were not genetically engineered”
  - “Our tomato growers do not plant seeds developed using biotechnology”





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# Summary

- A few major crops are sold as GE varieties
- Most people in the U.S. are eating foods that contain ingredients from a GE variety
  - Mostly highly refined ingredients
- Produce: sweet corn, papaya, summer squash



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- A few major crops are sold as GE varieties
- Most people in the U.S. are eating foods that contain ingredients from a GE variety
  - Mostly highly refined ingredients
- Produce: sweet corn, papaya, summer squash
  - Coming: potato, apple ??
- Credible evidence to date - safe as food & feed
  - Future products need to be evaluated
- **What do they offer to consumers?**



The background of the slide is a photograph showing the dark silhouettes of corn plants in the foreground. Behind them, a bright sunset or sunrise is visible, with the sun low on the horizon, casting a warm glow of orange and yellow light across the sky. The sky transitions from a bright orange near the horizon to a darker, purplish-blue at the top. The overall mood is peaceful and agricultural.

# Thank you!

Funding from USDA-NIFA Smith Lever Federal Capacity Funds and the College of Agriculture and Life Sciences at Cornell University is gratefully acknowledged.