



# Food Fights in the Marketplace: What Are the Issues with Engineered Crops (GMOs)?



*Peggy G. Lemaux*  
*University of California, Berkeley*  
<http://ucbiotech.org>  
<http://pmb.berkeley.edu/profile/plemaux#a1>







**1. How is genetic engineering different from classical breeding?**

**2. What GE crops are in commercial marketplace? In the pipeline?**

**3. Is everything we're eating genetically engineered?**

**4. What is the federal approval process for GE crops?**

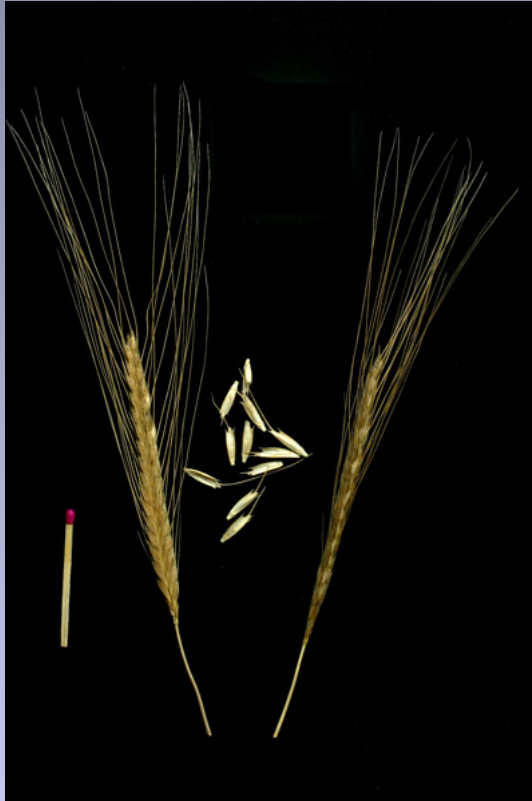


**5. Are there short- or long-term human food safety issues?**

**6. Do animals fed engineered foods have more organ damage?**

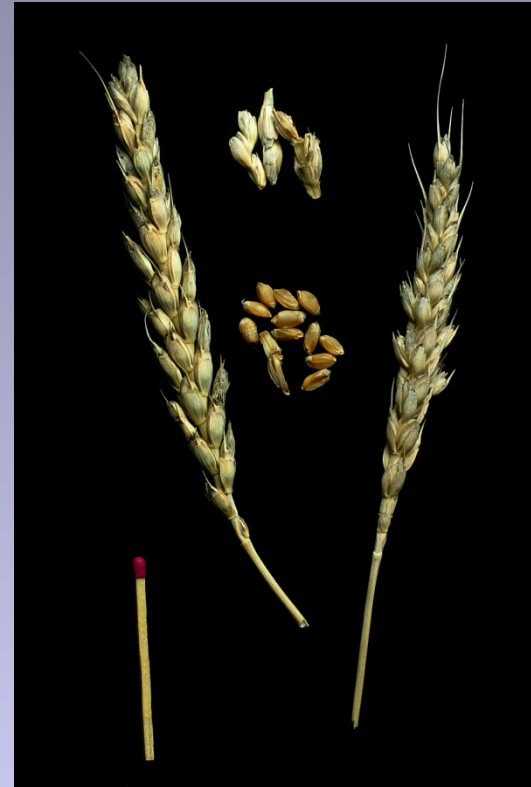


# How is the genetic information manipulated to create a new crop variety by classical breeding?



*Triticum monococcum*

**Ancient variety**



*Triticum aestivum*

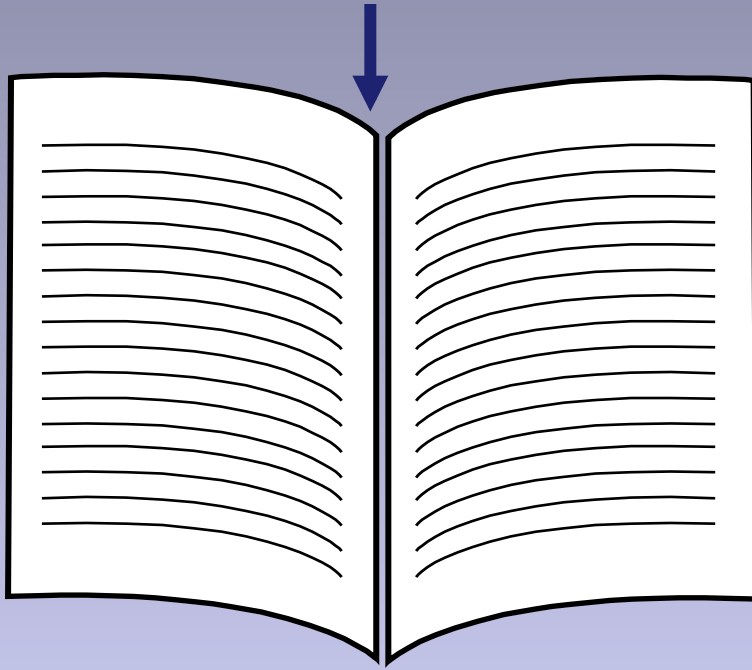
**Modern bread variety**



# Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...



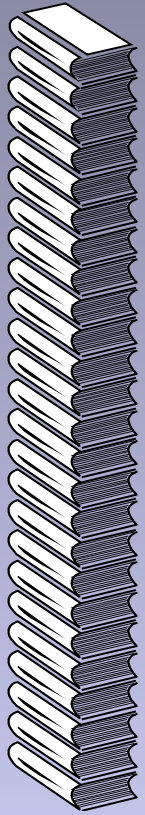
**1700 books**  
**1000 pages each**



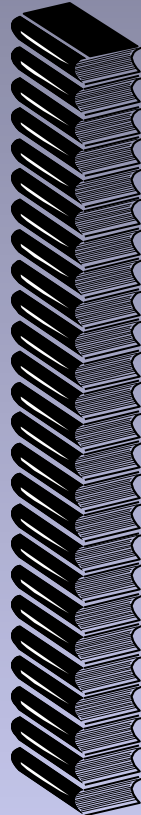
**1700 books**  
**(or 1.7 million pages)**



# Hybridization or cross breeding of wheat



**X**



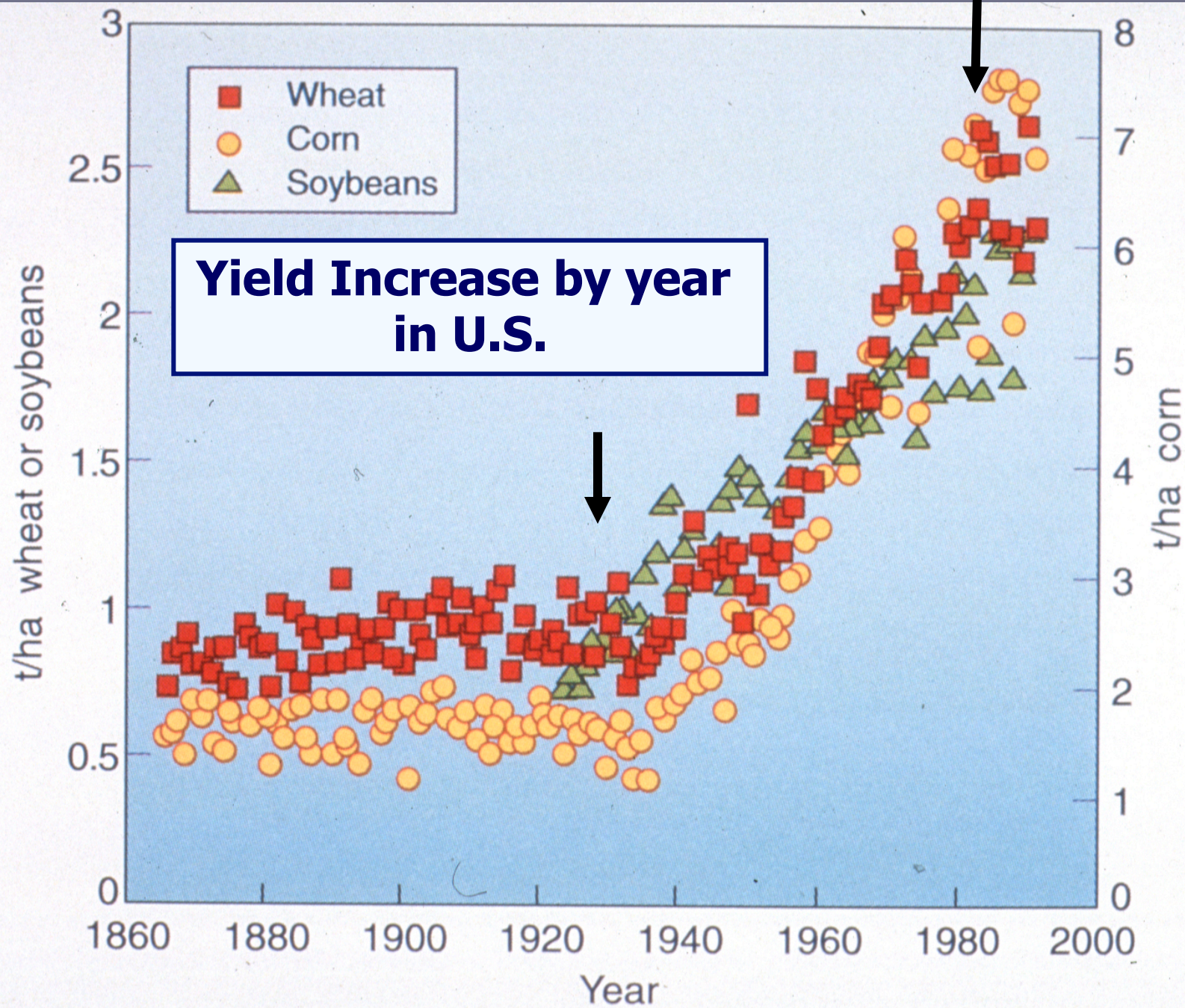
**Random  
retention of  
information  
from each  
parent**

**1700 books  
(or 1.7 million pages)**

**1700 books  
(or 1.7 million pages)**

**1700 books  
(or 1.7 million pages)**





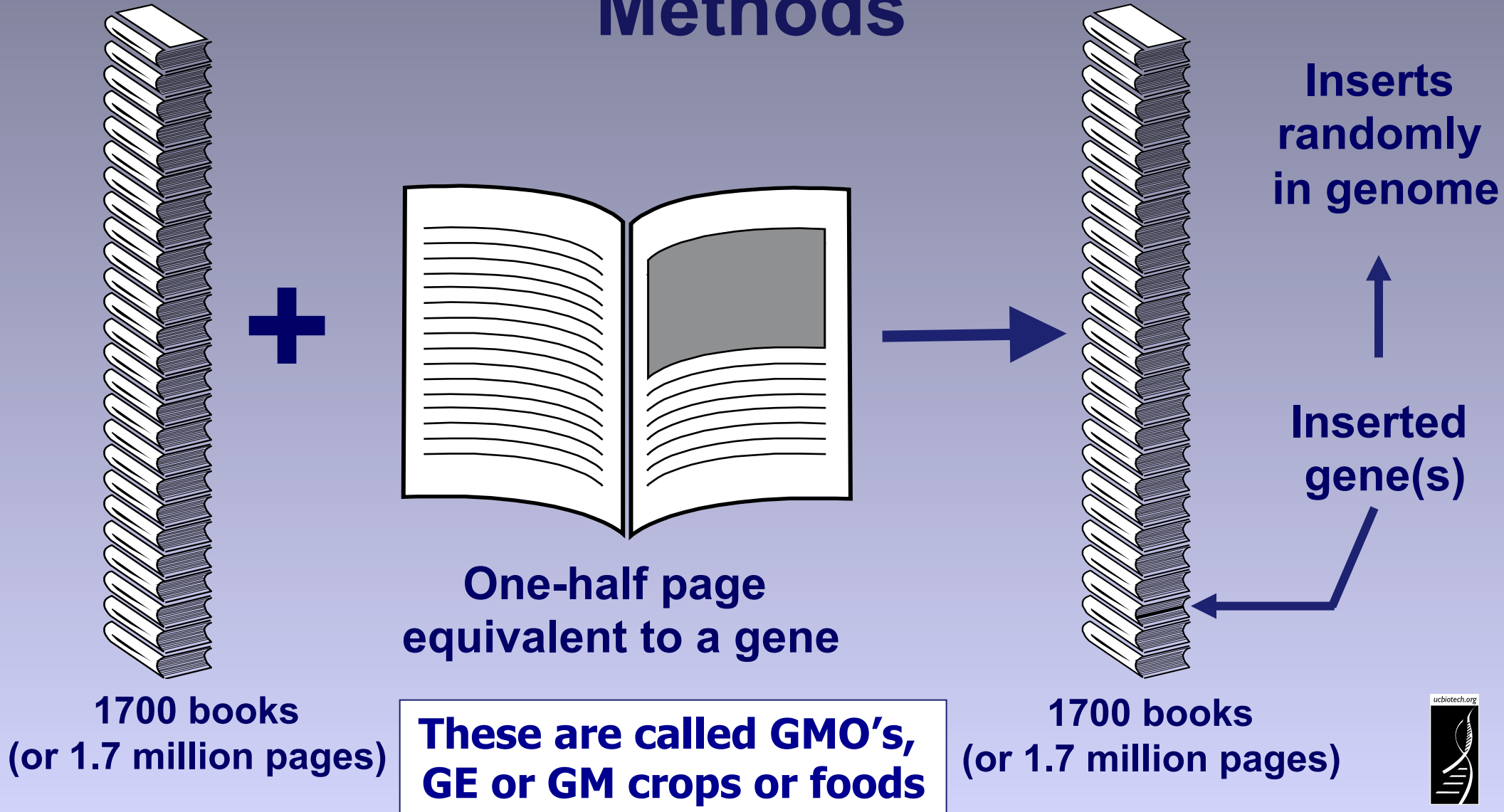




**How is the genetic information in a crop manipulated to create a new variety by genetic engineering or biotechnology?**



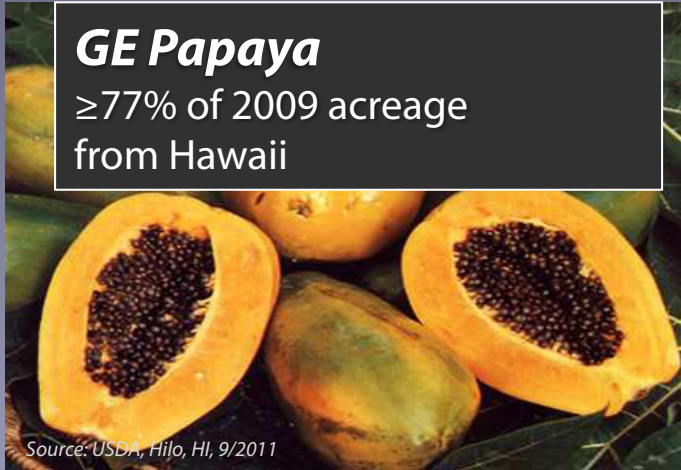
# Genetic Engineering or Biotechnology Methods





## **GE Papaya**

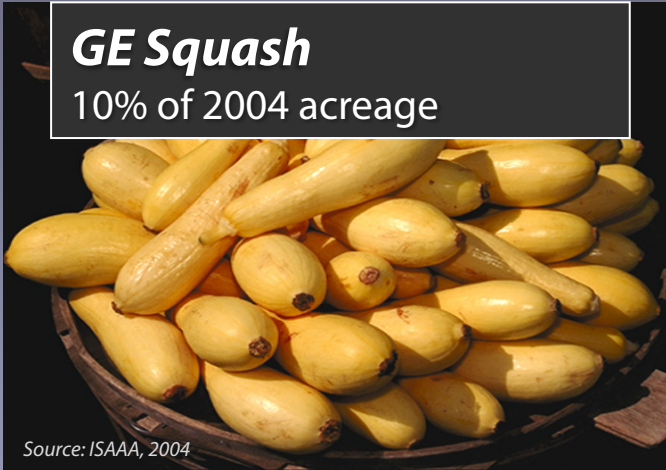
≥77% of 2009 acreage  
from Hawaii



Source: USDA, Hilo, HI, 9/2011

## **GE Squash**

10% of 2004 acreage



Source: ISAAA, 2004

**What GE crops  
are in commercial  
marketplace?**

## **GE Cotton**

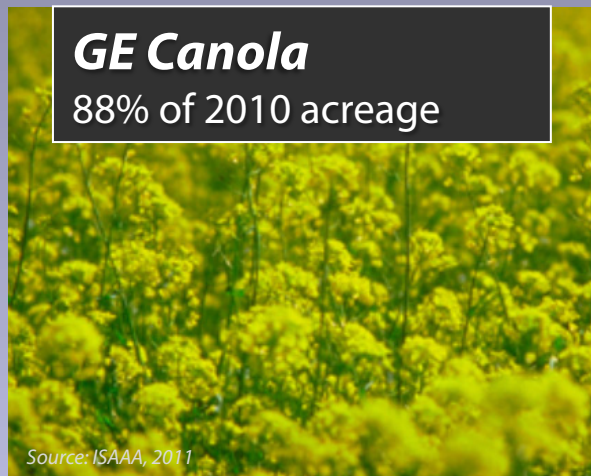
90% of 2013 acreage

(Insect Resistant: 8% Herbicide tolerant: 15% Stacked gene: 67%)



## **GE Canola**

88% of 2010 acreage

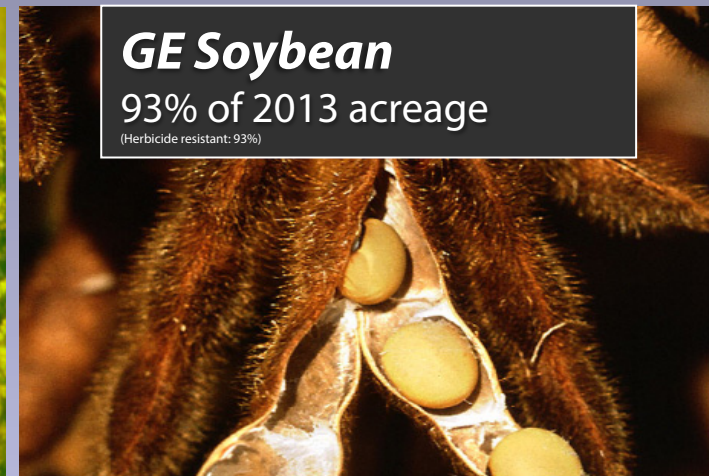


Source: ISAAA, 2011

## **GE Soybean**

93% of 2013 acreage

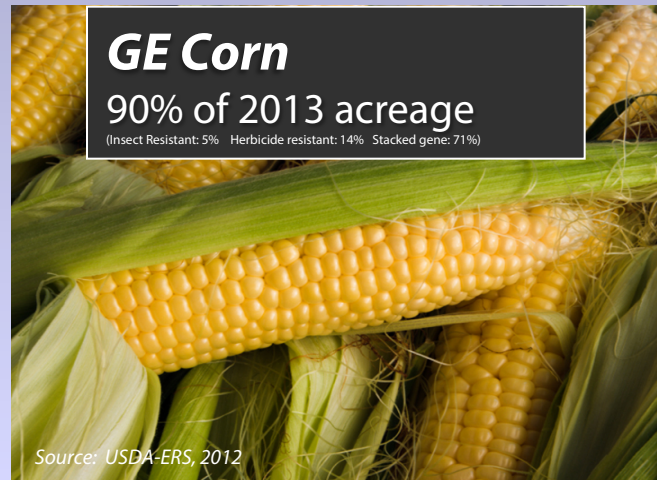
(Herbicide resistant: 93%)



## **GE Corn**

90% of 2013 acreage

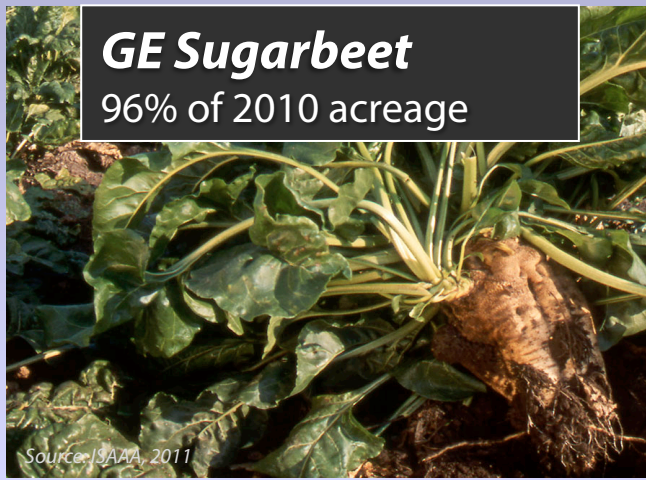
(Insect Resistant: 5% Herbicide resistant: 14% Stacked gene: 71%)



Source: USDA-ERS, 2012

## **GE Sugarbeet**

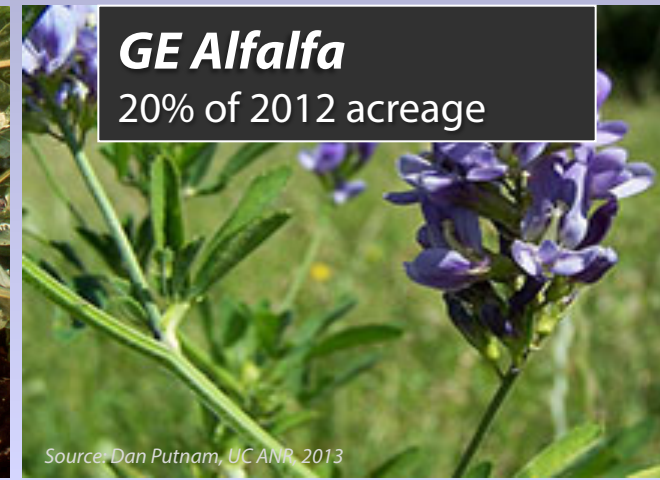
96% of 2010 acreage



Source: ISAAA, 2011

## **GE Alfalfa**

20% of 2012 acreage



Source: Dan Putnam, UC ANR, 2013



# Isn't everything we're eating genetically engineered?




**Types of GE Crops Leads To Estimates that 75% of Processed Foods in U.S. Have GE Ingredients in Minor Amounts**



# What GE crops are in the research pipeline?







*Australian researchers identify  
grape genes that provide resistance  
to powdery mildew*

SOURCE: Western Farm Press, volume 26, number 16







***Arcadia Biosciences develops canola that  
uses 50% less nitrogen fertilizer***

SOURCE: [http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet\\_april\\_10.htm#story0](http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet_april_10.htm#story0)





A photograph of a dense field of young corn plants. The plants are vibrant green with long, narrow leaves. In the background, a fence and some distant buildings are visible under a clear sky.

# *Yields in rice and maize increase under water-limiting conditions*

SOURCE: Castiglioni, P. et al. 2008. *Bacterial RNA Chaperones Confer Abiotic Stress Tolerance in Plants and Improved Grain Yield in Maize under Water-Limited Conditions*. *Plant Physiology* 147: 446-455.





A photograph of a whole green apple at the top and two apple slices below it, all resting on a light-colored marble surface. A green rectangular box with a black border is superimposed over the center of the image, containing white text.

*Non-browning GE apple will be marketed in U.S. and labeled as genetically modified*

SOURCE: "Stop Genetically Engineered Apples!", Organic Consumers Association, 3/24/11.  
<http://www.organicconsumers.org/bytes/ob269.htm#SEC3>





The background of the entire slide is a close-up, high-resolution photograph of numerous green pea seeds. The seeds are spherical, have a slightly wrinkled texture, and are a vibrant green color. They are packed closely together, filling the entire frame.

# *Engineered Pea Seeds Protect Chickens against Parasitic Coccidiosis*

SOURCE: "Engineered pea seeds protect against parasites", BioMed Central, 9/10/09, [http://www.eurekalert.org/pub\\_releases/2009-09/bc-eps090909.php](http://www.eurekalert.org/pub_releases/2009-09/bc-eps090909.php)  
Zimmermann, J., Saalbach, I., Jahn, D., Giersberg, M., Haehnel, S., Wedel, J., Macek, J., Zoufal, K., Glunder, G., Falkenburg, D. and Kiprijanov, S.M. 2009. Antibody expressing pea seeds as fodder for prevention of gastrointestinal parasitic infections in chickens. BMC Biotechnology, in press.





# *Slow-Mow grass addresses watering, maintenance and weed problems*



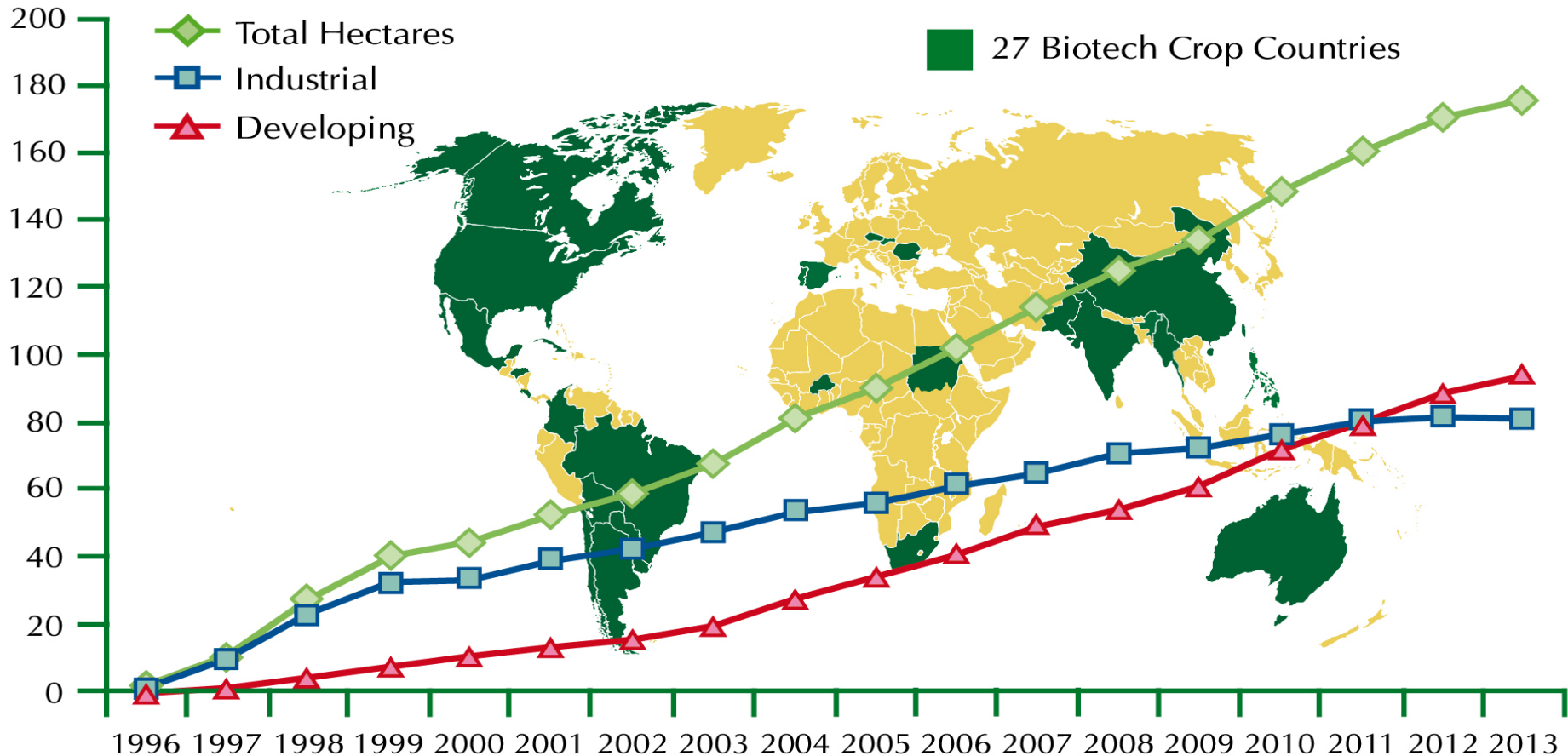
SOURCE: "Engineering a mow-less lawn", New York Times, 4/22/06  
[http://www.nytimes.com/2006/04/22/business/22offline.html?\\_r=1&oref=slogin](http://www.nytimes.com/2006/04/22/business/22offline.html?_r=1&oref=slogin)





# Why do we even need genetic engineering?

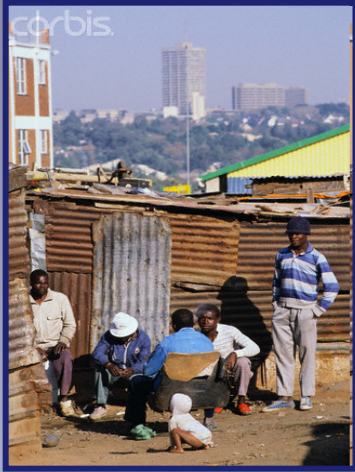
GLOBAL AREA OF BIOTECH CROPS  
Million Hectares (1996-2013)



**2013 figures indicate 15.4 million farmers in 27 countries planted 433M acres (>3X California) – over 90% were small resource-poor farmers in developing countries**



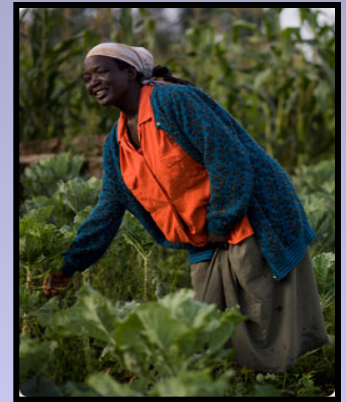
# Consider this...perhaps needs are greatest in developing countries



❖ One billion of the world's poorest people live on  $\leq$  \$1 per day.

❖ No country has risen rapidly from poverty without increasing agricultural productivity

❖ Perhaps GE crops can help?





**What is the federal approval process  
for GE crops?**



# U.S. Regulatory Agencies

## USDA

- **Field testing**  
-Permits  
-Notifications
- **Determination of non-regulated status**

Plant pest?

## FDA

- **Food safety**
- **Feed safety**

Danger to people?

## EPA

- **Pesticidal plants**  
-tolerance  
exemption  
-registrations
- **Herbicide registration**

Risk to environment?



# APHIS Determines Nonregulated Status – 86 granted

(8-11-2012)

**Once nonregulated, organism  
no longer requires APHIS review  
for movement or release in U.S.**

- ✓ Alfalfa – HT –removed, reinstated
- ✓ Corn - HT, IR, AP
- ✓ Cotton - HT, IR
- ✓ Soybean - HT, PQ
- ❖ Potato - IR, VR
- ❖ Tomato - PQ
- ❖ Squash - VR
- ✓ Canola – HT
- Papaya - VR
- ❖ Rice - HT
- Rapeseed - HT, AP, PQ
- ✓ Sugar beet - HT
- ❖ Flax - HT
- Chicorium - AP
- Tobacco – PQ
- Rose - PQ

- ✓ Large-scale production
- ❖ Not on market

([http://www.aphis.usda.gov/brs/not\\_reg.html](http://www.aphis.usda.gov/brs/not_reg.html))





*RR sugar beets deregulated and then challenged. U.S. Circuit Court denies lawsuit aimed at preventing growers from planting GE sugar beets. EIS published; deregulation status reinstated July 20, 2012*



<http://www.fas.org/sgp/crs/misc/R41395.pdf>



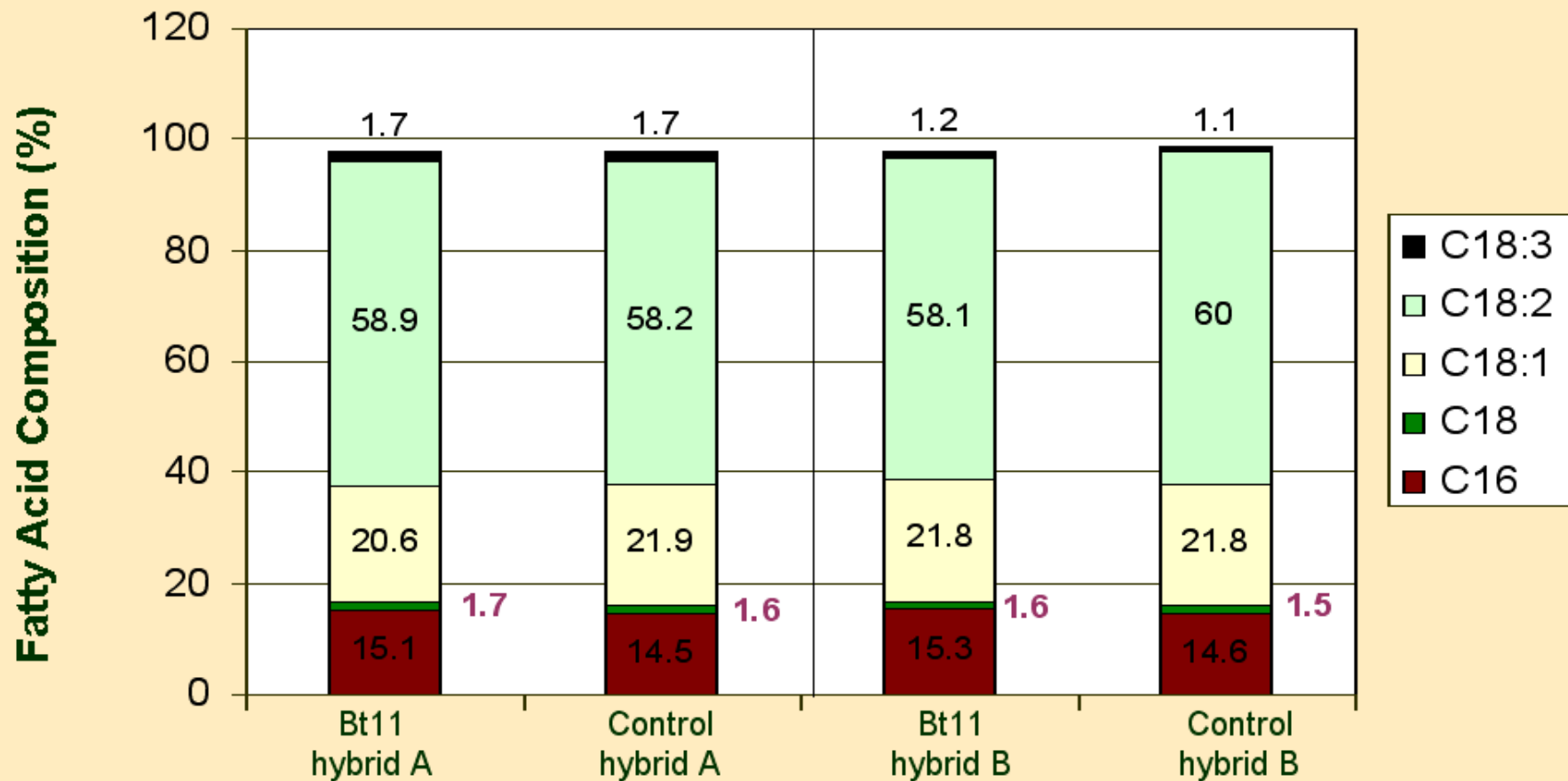
FDA uses the concept of  
**substantial equivalence:**

**Modified food has essentially all characteristics of nonmodified food with respect to food and feed value  
except**

**for the introduced genetic material and the products made from it. These products are tested and analyzed separately for specificity and mode of action of protein, source of protein, stability during digestion and processing**



# Substantial Equivalence: Fatty Acids

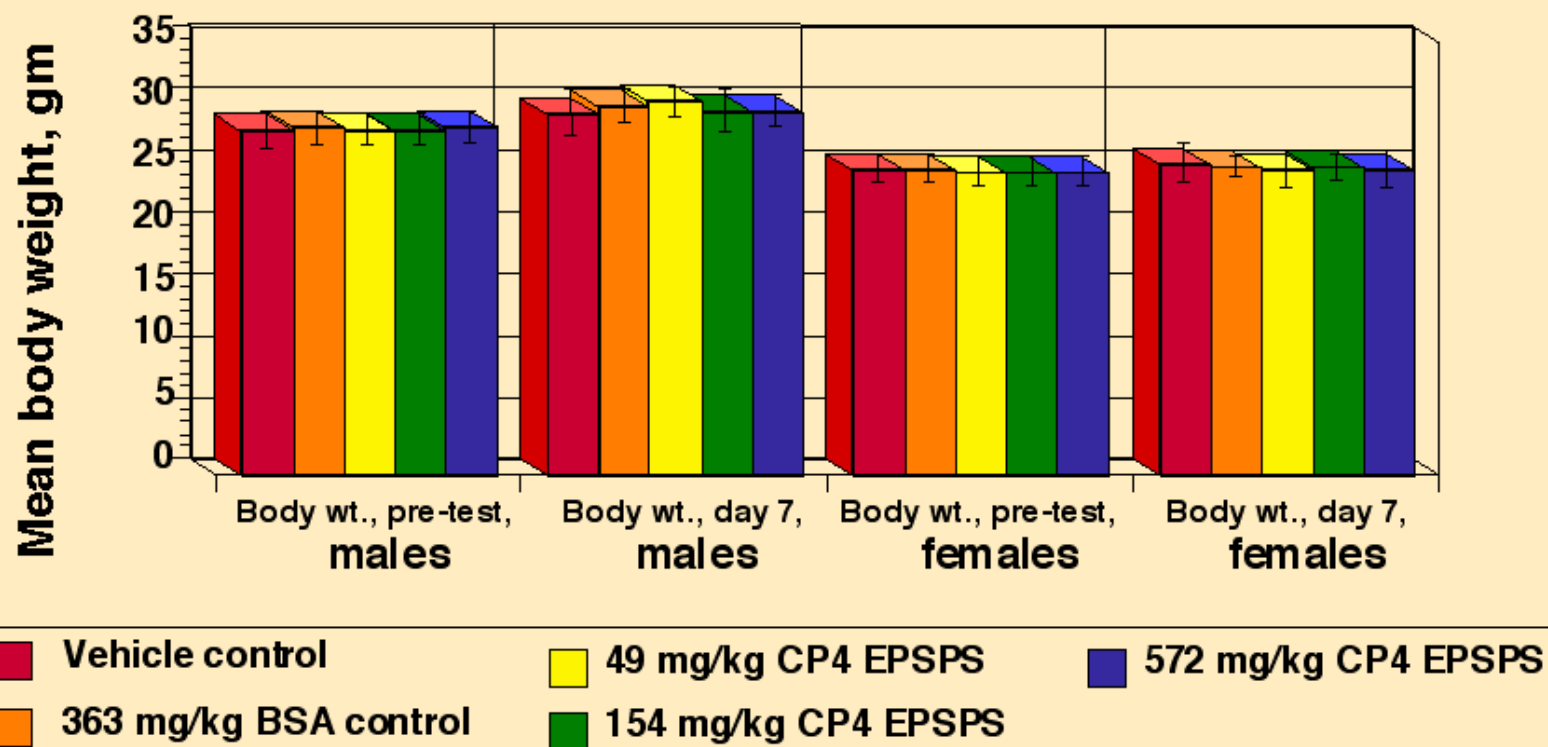


These results have been generated on Event Bt 11. Data showing similar fatty acid composition have been generated on the other corn events.



# ***Toxicity Assessment: Roundup Ready/CP4 EPSPS protein***

***No deleterious effects at highest dose (572mg/kg)***





# Why Are GE Crops and Foods (GMOs) So Controversial?





# ***It started in Europe: Factors that fueled controversy in Europe***

- **Food safety scares**
- **Involuntary nature of the change**
- **Cultural differences**
- **Economic incentives**







## Co-existence issues between organic and engineered crops and foods



Investigative report

# Monsanto's practices weed out competition

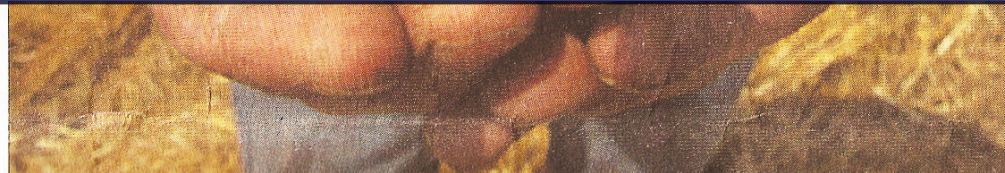
*Licensing pacts, science propel seed company to dominate position*



- Large agrichemical companies are creating today's commercial GE crops.
- They control most of the intellectual property.
- This may or may not be good for agriculture.

Associated Press investigation has found.

With Monsanto's patented genes being inserted into roughly 95 percent of all soybeans and 80 percent of all corn grown in the U.S., the company also is using its wide reach to control the ability of new biotech firms to get wide distribution for their products, according to a review of several Monsanto licensing



A farmer holds Monsanto's Roundup Ready soybean seeds. Confidential contracts detailing Monsanto Co.'s business practices reveal how the world's biggest seed developer protects its dominance over the multibillion-dollar market for genetically altered crops, an Associated Press investigation has found.

Dan Gill/Associated Press

SOURCE: Capital Press, December 18, 2009



# Are there short- or long-term human food safety issues?





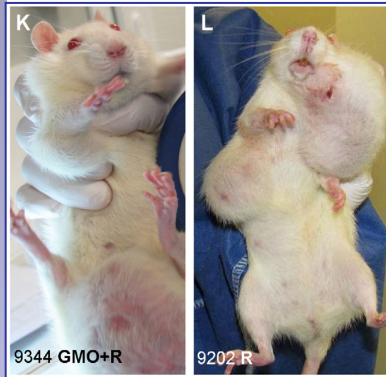
**Intermittent studies are published casting doubts on GE food safety, like this one published by a French researcher in Sept. 2012 –**

**Subsequently reviewed by European Food Safety Authority and found to have no merit.**

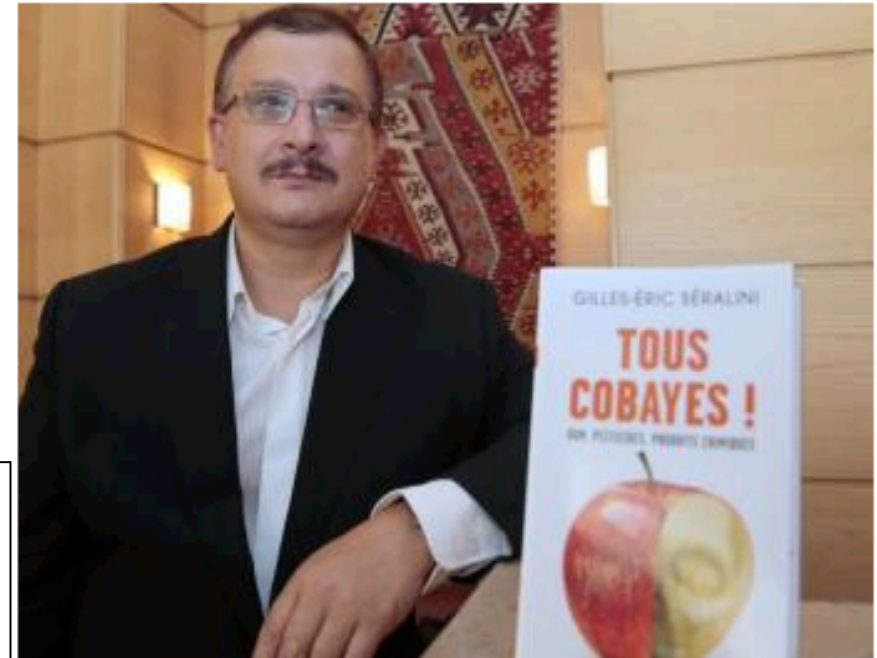
## French academies trash GM corn cancer study

By RFI

A controversial study that linked genetically modified maize to cancer in lab rats is a "scientific non-event", six French scientific academies said in a rare joint statement Friday.



**Claim that Monsanto's RR corn causes tumors in rats**



The report's author, Gilles-Eric Seralini, with his book All Guineapigs  
AFP / Jacques Demarthon

**It's stories like these that capture consumers' attention...even featured on Dr. Oz show**

veterinary studies.



# Are there allergy problems with GE foods?



- Oct 2000: StarLink *Bt* gene found in foods, forced massive recalls
- People claimed allergic reactions, but no StarLink was found in food
- Likely allergic reactions not due to Starlink
- No other medically confirmed allergic reactions to GE foods
- Efforts to check allergenicity of introduced GE products before market
- Allergic reactions to GE foods could occur, also with classically bred foods



# 2012 Meta-analysis Review from France

**Twelve long-term (>90d to 2yr) and Twelve multigenerational (2 to 5 generations) feeding trials in animals of five GE crops**

- **Nutritionally equivalent to non GE foods**
- **Can be safely consumed in food and feed**



**maize**

**potato**



**soy**

**rice**



**triticale**



**Anne Glover, the first European chief scientific adviser, appears to look at science and technology in a different light than many Europeans.**



“I would be confident in saying that there is no more risk in eating GMO food than eating conventionally farmed food...it has nothing to do with genetic engineering... I would argue that we use every technical possibility – not just GMOs – it requires every tool in our toolkit to deliver.”



# Do animals fed engineered foods have more organ damage?

Used ~80 pigs on GM and non-GM diet for ~22 weeks

## Claims:

- No differences for feed intake, weight gain, mortality, and blood biochemistry
- Noted gastric and uterine differences
- Higher rate of severe stomach inflammation

## Thoughts on study:

- Food Standards of Australia and New Zealand, like the US FDA, concluded data gave no reason to change their determination of safety of these GE varieties



Figure 1. Different levels of stomach inflammation found (clockwise from top left): nil (from a non-GM-fed pig, number B41), mild (from a non-GM-fed pig, number B15), moderate (from a GM-fed pig, number C34) and severe (from a GM-fed pig, number D22).

- No dose-response, i.e., heaviest uterus in GM group weighed < heaviest uterus in non-GM group
- Did not control for different crop varieties used or for contamination in grain
- Did not look for indications of inflammation other than red color (due to other conditions?)
- Animals used for the study did not appear to be in optimal health




Have more  
questions?  
Check the  
Biotech  
information  
section of  
[http://  
ucbiotech.org](http://ucbiotech.org)

ucbiotech.org - Science-Based Information and Resources on Agriculture, Food and Technology

ucbiotech.org - Science-Based I...

ucbiotech.org/index.html

Google



**ucbiotech.org** SCIENCE-BASED INFORMATION & RESOURCES ON AGRICULTURE, FOOD & TECHNOLOGY

ABOUT US | IN THE NEWS | **BIOTECHNOLOGY INFORMATION** | RESOURCES | LINKS | GLOSSARY | SEARCH


Annual Review Articles | Issues & Responses

Select Language ▼

### know GMOS

*This website provides educational resources focused broadly on issues related to agriculture, crops, animals, foods and the technologies used to improve them. Science-based information related to these issues is available, as well as educational tools and information, which can be used to promote informed participation in discussions about these topics.*


### FEATURED PRESENTATION



**How Much Did You Pay for Your Lunch Today?**

Center for Practical and Professional Ethics  
California State University, Sacramento  
February 7, 2012

#### BIOTECHNOLOGY INFORMATION



**ANNUAL REVIEWS**

Review articles:  
Focused on food, environmental and socioeconomic issues of GE crops and foods.  
[Part 1](#) | [Part 2](#)


#### RESOURCES FOR OUTREACH & EXTENSION, RESEARCHERS & TEACHERS

DNA for Dinner 4-H curriculum:  
For grades 5-8, covers topics from plant diversity to genetic engineering. Each of the five lessons has 3 to 5 activities.



**DNA FOR DINNER?**


New Game: Who's In Your Family?  
A free educational game to teach participants about the diversity of fruits and vegetables, and how they are related.



Slide Archive:  
Extensive collection of PP slides on agriculture & biotechnology.

**Available on loan:**

Teaching Aids: Handouts and cards available, in both English and Spanish.



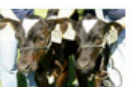
Educational displays: "Genetics and Foods" and "Genetic Diversity and Genomics" available with companion educational cards and teacher

#### HELPFUL SITES

**Academics Review**  
Academics Review website  
Testing popular claims against peer-reviewed science.

**BIOFORTIFIED**  
Biofortified website  
Provides factual information to foster discussion about agriculture, especially plant genetics and genetic engineering.

Animal Genomics & Biotechnology Cooperative Extension Program, UC Davis  
Provides education on use of animal genomics & biotechnology in livestock production.





"Food Fights in the Marketplace: What are the Issues with Engineered Crops (GMOs)?"

What is genetic engineering, explain terms GE, GM, GMO and biotechnology  
What is traditional breeding vs. genetic engineering. All breeding is genetic modification.

Why do we even need genetic engineering?

Why is genetic engineering so controversial?

What GE traits are currently marketed?

What does the future bring as far as GE crops in the short and long term?

What is the approval process for GE crops?

How are the potential risks to human health evaluated and assessed?

Are there long-term health effects of foods from genetically engineered plants?

Are foods from GE crops more likely to cause an allergic reaction?

Is there any truth to the claims that animals fed GE crops have organ damage?

**In your professional opinion what are the risks associated with GE crops? -  
Putnam and PGL**