

ANGST in the GROCERY AISLE

The Debate over Genetically Modified Foods



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

GMO - YES



The American Association for the Advancement of Science (AAAS) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.



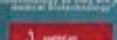
The National Academy of Sciences is a preeminent U.S. institution in the field of science. It has concluded that the use of genetic engineering in agriculture is safe.

"To date, more than 100 million acres of genetically modified crops have been grown worldwide, and no evidence of harm to the health of those crops or to the health of those who have eaten them has been found."



The American Chemical Society (ACS) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

"With the overwhelming participation of scientists at all levels, it is concluded that the use of genetic engineering in agriculture is safe."



The American Society for Human Genetics (ASHG) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

"The ASHG is in full support of the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe."



The Crop Science Society of America (CSSA) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.



The Center for Science and Technology (CAST) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

"Genetically modified crops are safe for human consumption and the environment. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe."



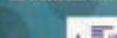
The Federation of Animal Science Societies (FASD) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

"Genetically modified crops are safe for human consumption and the environment. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe."



The Society of Toxicology (SOT) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

"Genetically modified crops are safe for human consumption and the environment. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe."



The U.S. House of Representatives supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

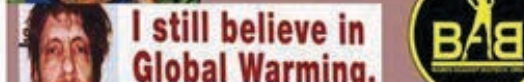
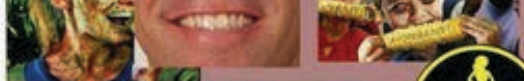
"Genetically modified crops are safe for human consumption and the environment. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe."



The International Council for Science (ICSU) supports the use of genetic engineering in agriculture and biotechnology. The science is quite clear: crop improvement by the use of modern techniques of biotechnology is safe.

GMO - NO

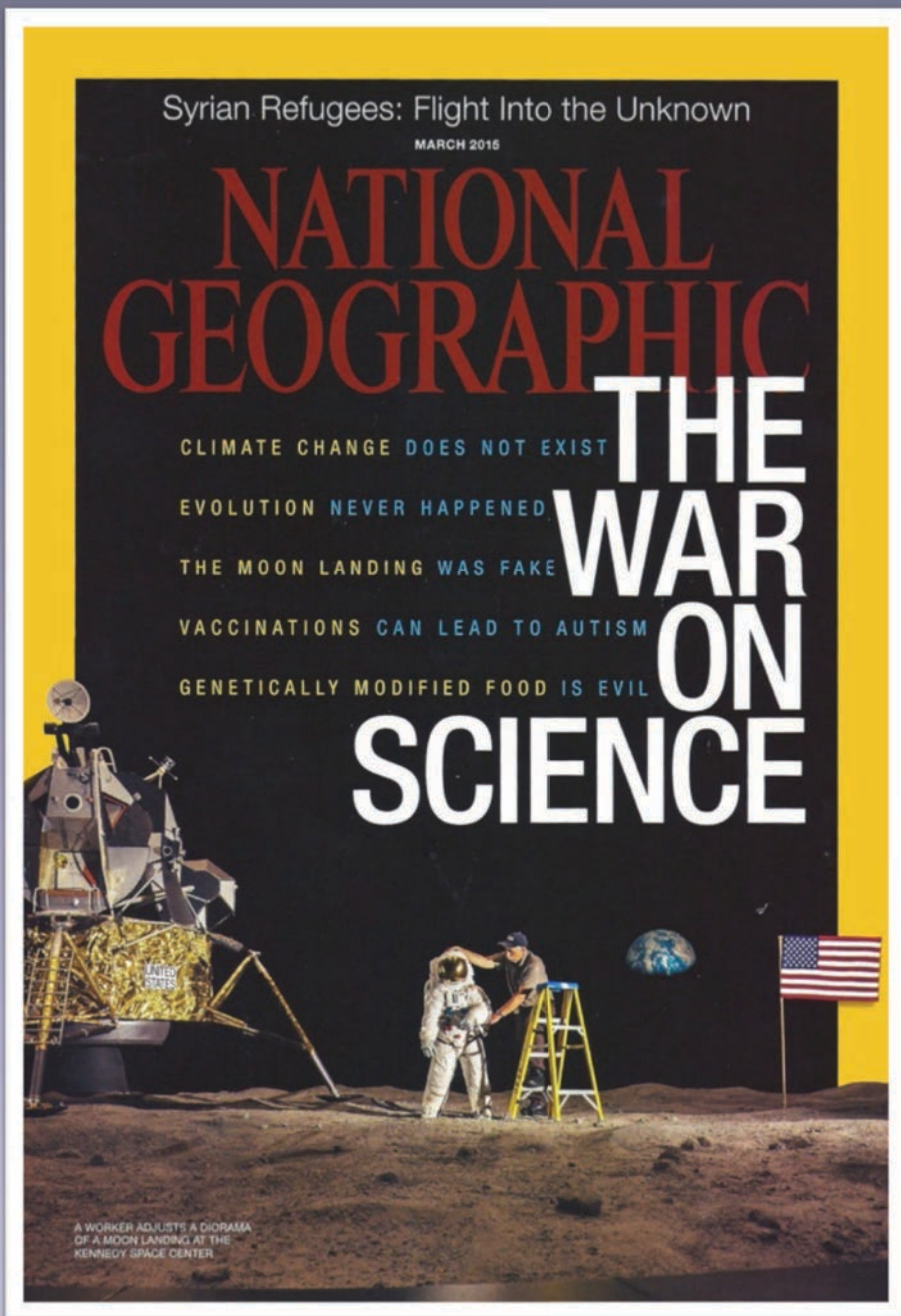
DESTRUCTION



The debate over GMO's has gone on for some time.

But is public concern just about genetically engineered foods (GMO's)?





There seems to be angst about many contemporary issues

Consider the March 2015 scholarly *National Geographic* article highlighting public concerns and discussing the role science plays in people's thinking about...

- Climate Change
- Evolution
- Vaccination
- Moon Landing
- Genetically Modified Foods, GMO's

Do scientists' views differ from the public's on certain topics?

Yes, views of the public and scientists often disagree

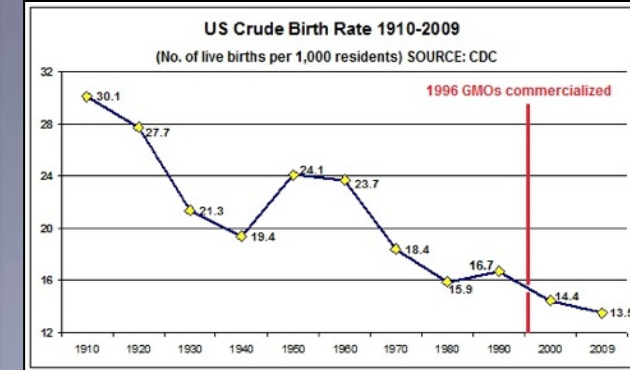
Agree to disagree?

Percent of U.S. adults and AAAS scientists who say the following...

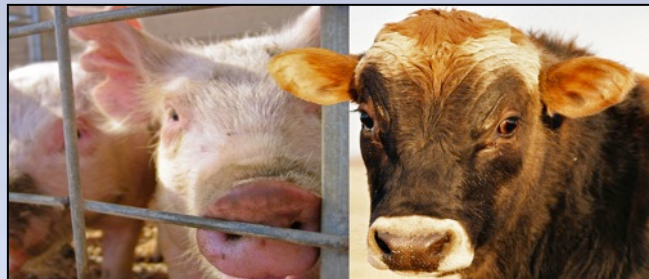
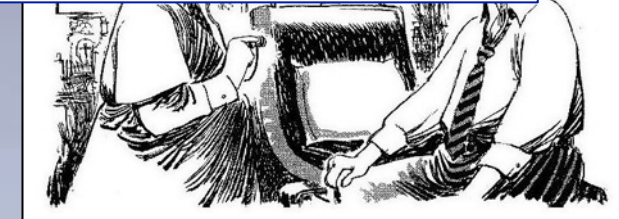
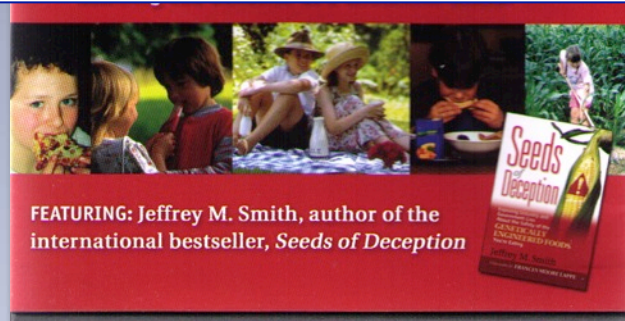
| | U.S. ADULTS | SCIENTISTS |
|-------------------------------|-------------|------------|
| GMO foods are OK to eat. | 37% | 88% |
| Humans have evolved. | 65% | 98% |
| Require childhood vaccines. | 68% | 86% |
| Humans worsen climate change. | 50% | 87% |
| Increase fracking. | 39% | 31% |
| Drill more offshore. | 52% | 32% |

SOURCE: Pew Research Center, January 29, 2015, "Public and Scientists' Views on Science and Society"
<http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/>

While each of these topics would be an interesting Skeptical talk, mine focuses primarily on issues with genetically engineered (GE, GMO) crops and foods.



Let's first talk about how genetic modification has figured into changing our foods over time



Farmers say pigs and cows became sterile



Do Foods Look Different Today than They Did Before?



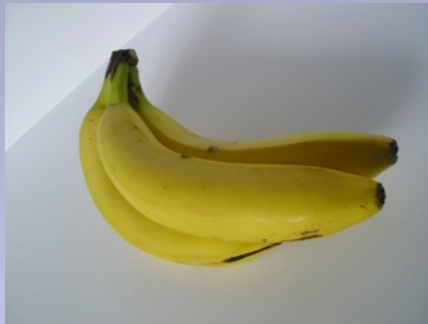
Carrot



Eggplant



**Broccoli, Kale,
Cabbage**



Modifications happened via
WHY?
spontaneous mutations,
intercrossing and natural
selection



But more recently humans have been intentionally involved in modifying plants using classical breeding?



Triticum monococcum
Ancient variety



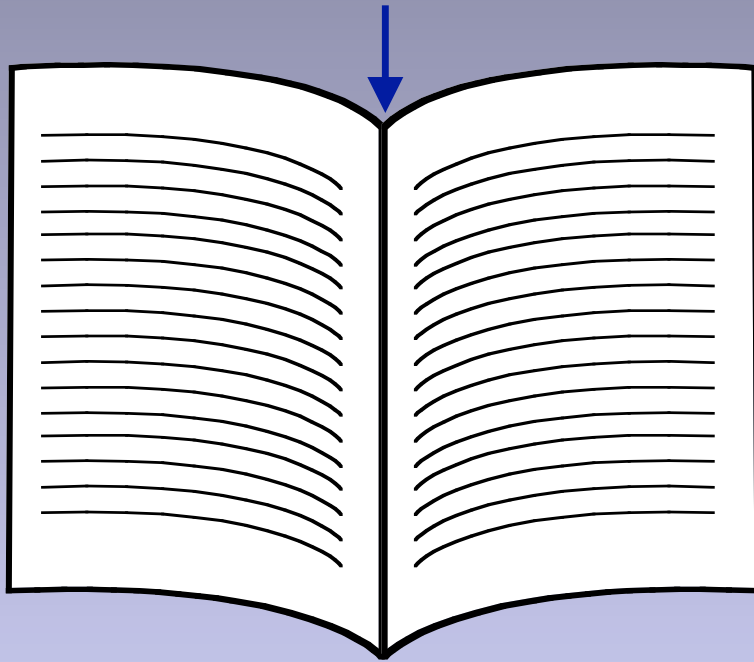
Triticum aestivum
Modern bread variety

What
happens
genetically
during this
process?

Genetic Information in Cells of Wheat Plant

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...

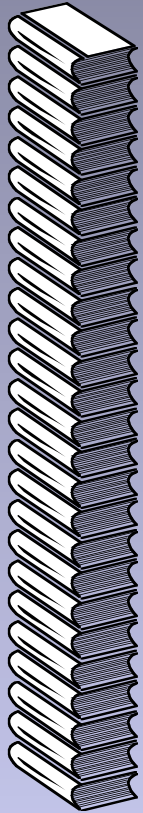


1700 books
1000 pages each



1700 books
(or 1.7 million pages)

What happens during classical breeding?



X



Random
retention of
~50% of
information
from each

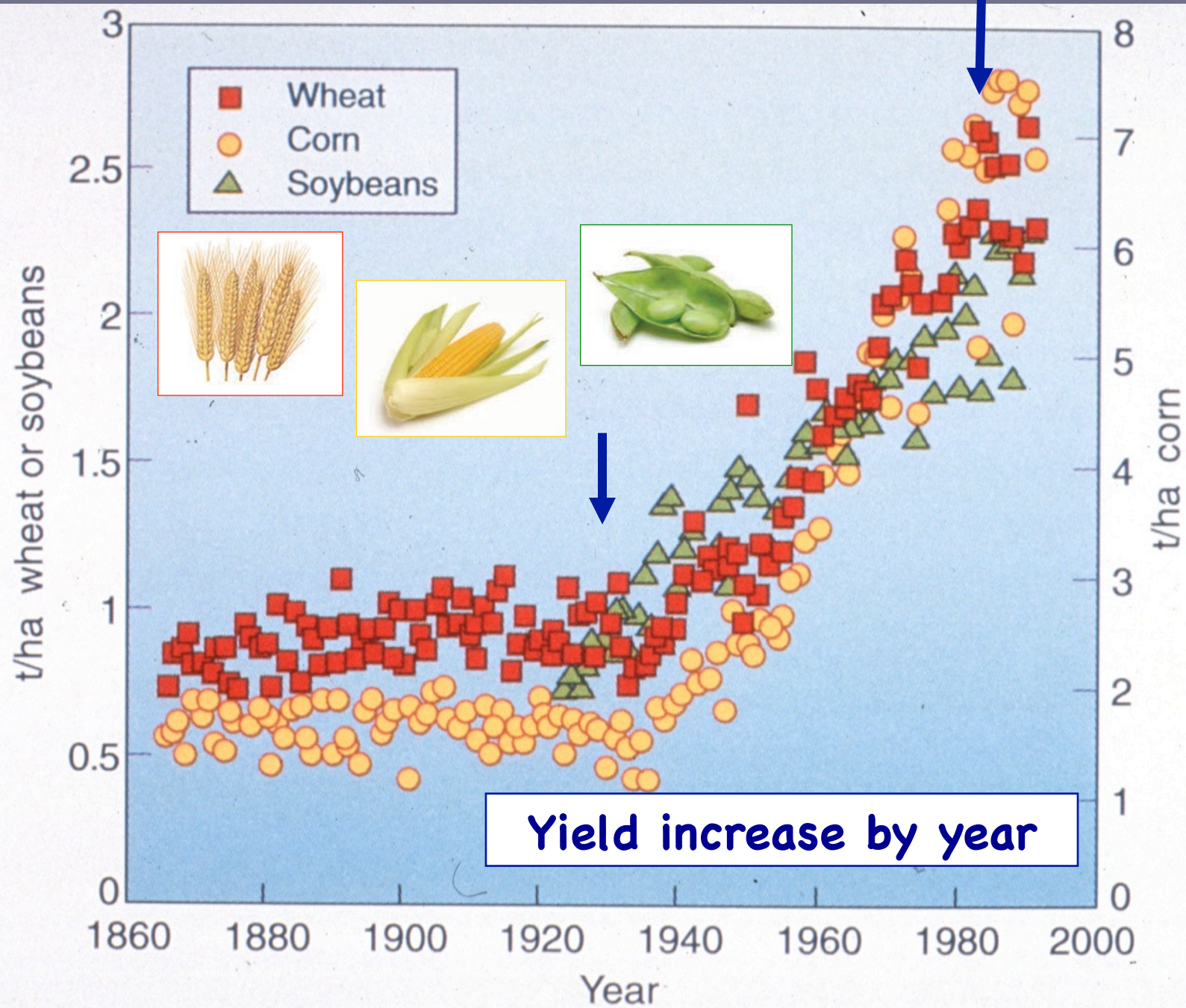
**What is the outcome of
the cross?**

1700 books
(or 1.7 million pages)

1700 books
(or 1.7 million pages)

1700 books
(or 1.7 million pages)

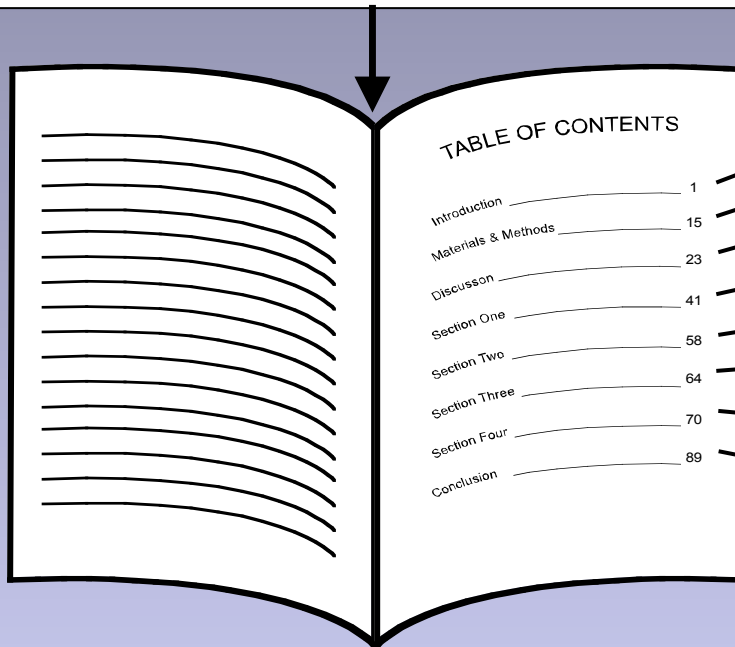
Genetic modification that is not GE or GMO



New ways to do breeding...

Uses table of contents of genes (genomics) for
marker assisted selection

...CTGACCTAATGCCGTA...



Increases
speed of
breeding
process

Genetic modification that is not GE or GMO

1700 books
(or 1.7 million pages)



Can't We Just Do All Modification This Way?

**Marker-assisted selection used to protect rice
against bacterial blight and blast disease**

Limited to diversity in crop and compatible relatives



**What other ways can the
modern tools of genetics be
used to create new varieties?**

Genetic Engineering

**What Kinds of GE Crops and Foods
Are in the Commercial Market?**

One-half page
equivalent to a gene

Inserts
randomly
in genome

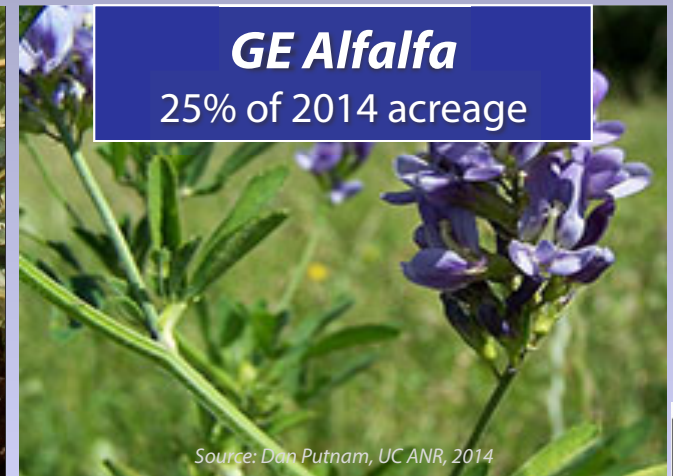
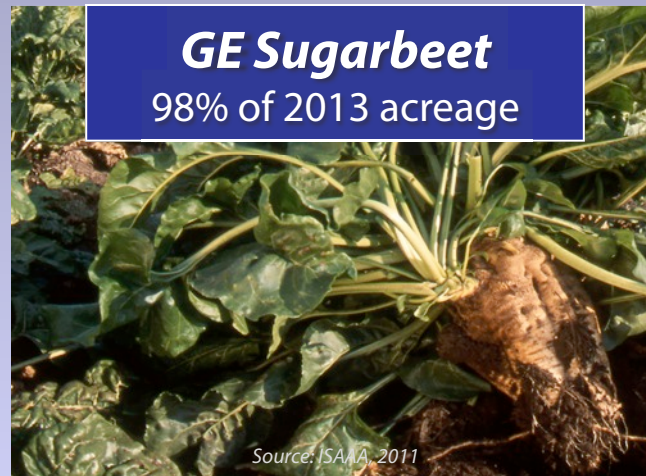
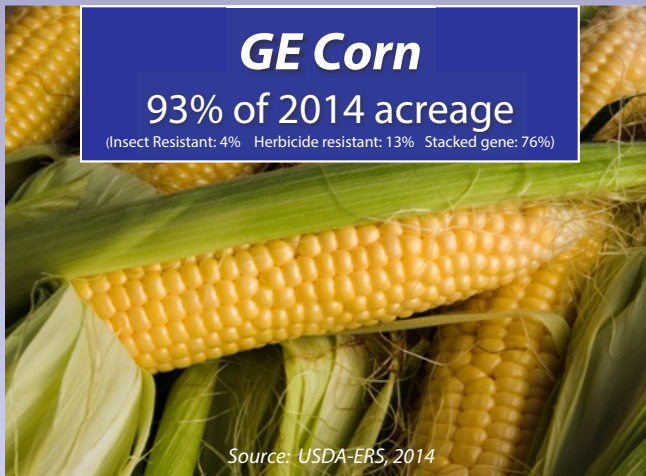
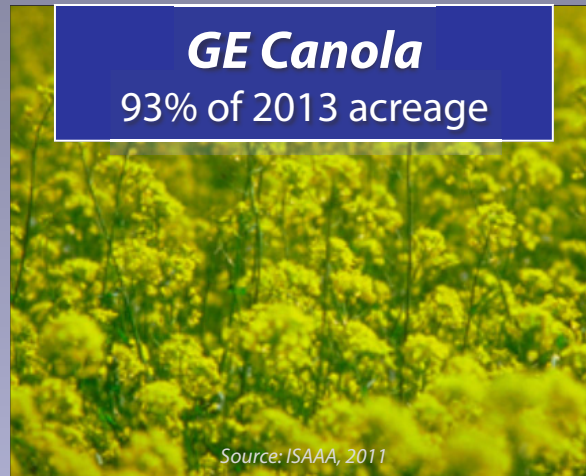
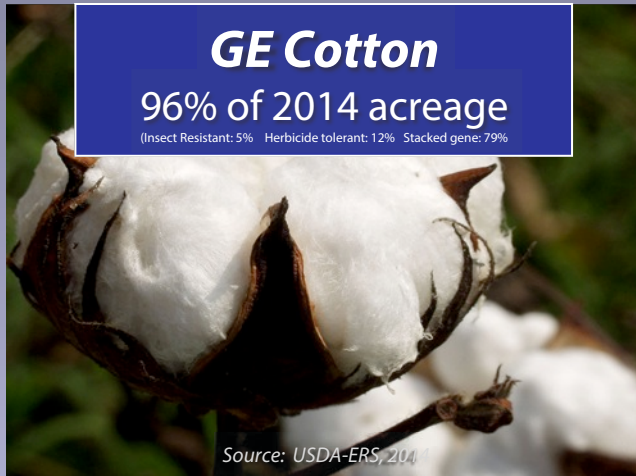
Inserted
gene(s)

1700 books
(or 1.7 million pages)

1700 books
(or 1.7 million pages)

Genetic modification that is GE and GMO

Number of commercial large acreage GE crops in U.S. is limited



**Number of different traits
available in large acreage
GE crops is also limited**

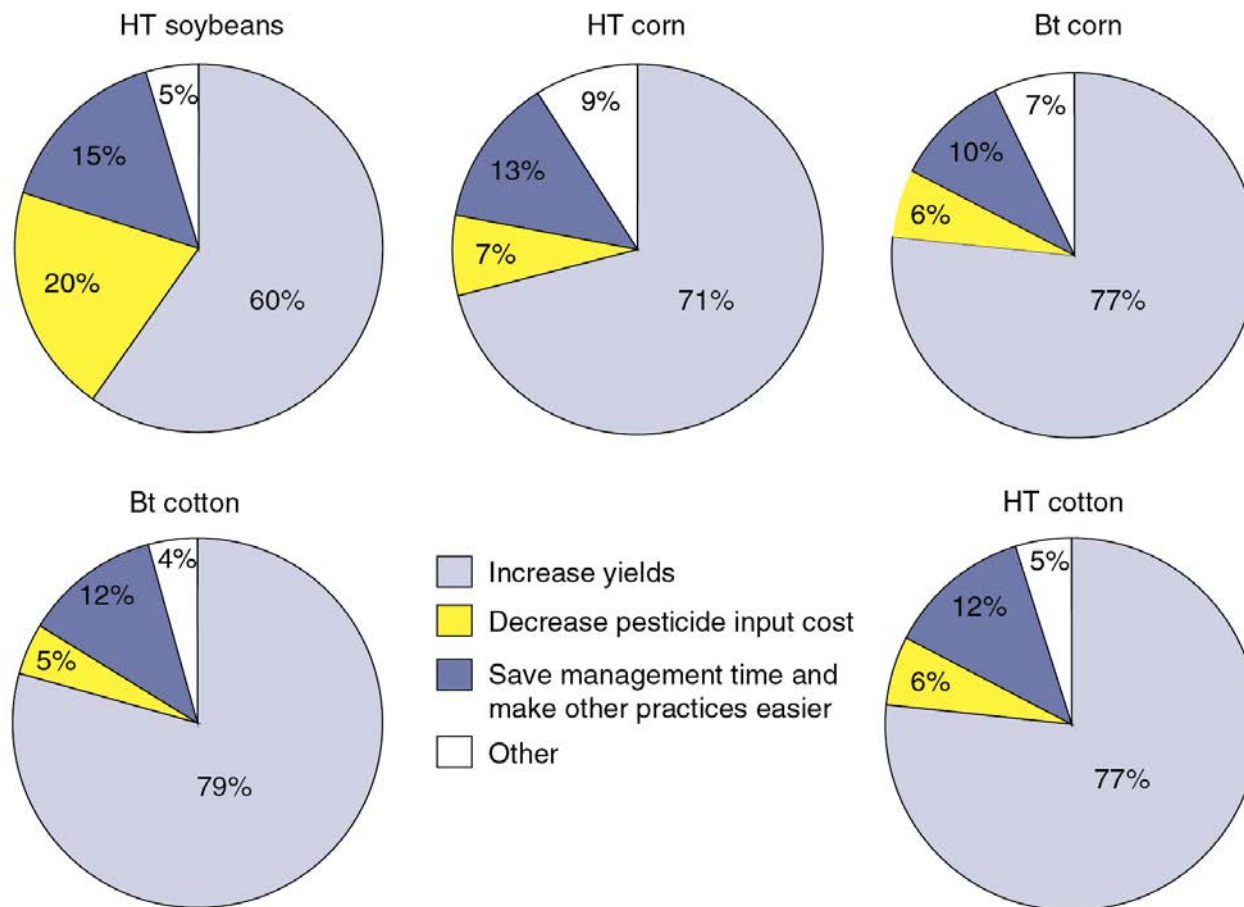


**Insect-tolerant Bt crops -
engineered for resistance
using gene from naturally
occurring bacterium**



**Herbicide-tolerant -
engineered with gene to
tolerate herbicide
application**

Why do U.S. growers use GE crops?



Reasons vary from crop-to-crop but primary reason is improved yields

SOURCE: Fernandez-Cornejo, J., Wechsler, S., Livingston, M. and Mitchell, L. 2014. Genetically Engineered Crops in the United States. USDA Economic Research Service Report No. 162, February 2014.



These types of large-acreage GE crops lead to estimates that 60-80% of processed foods in U.S. have GE ingredients

SOURCE: <https://factsaboutgmos.org/disclosure-statement>

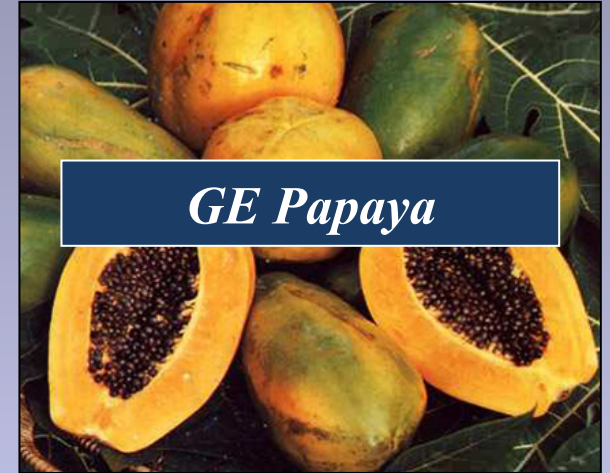
Only a few whole, GE foods are
in the commercial U.S market



GE Sweet Corn

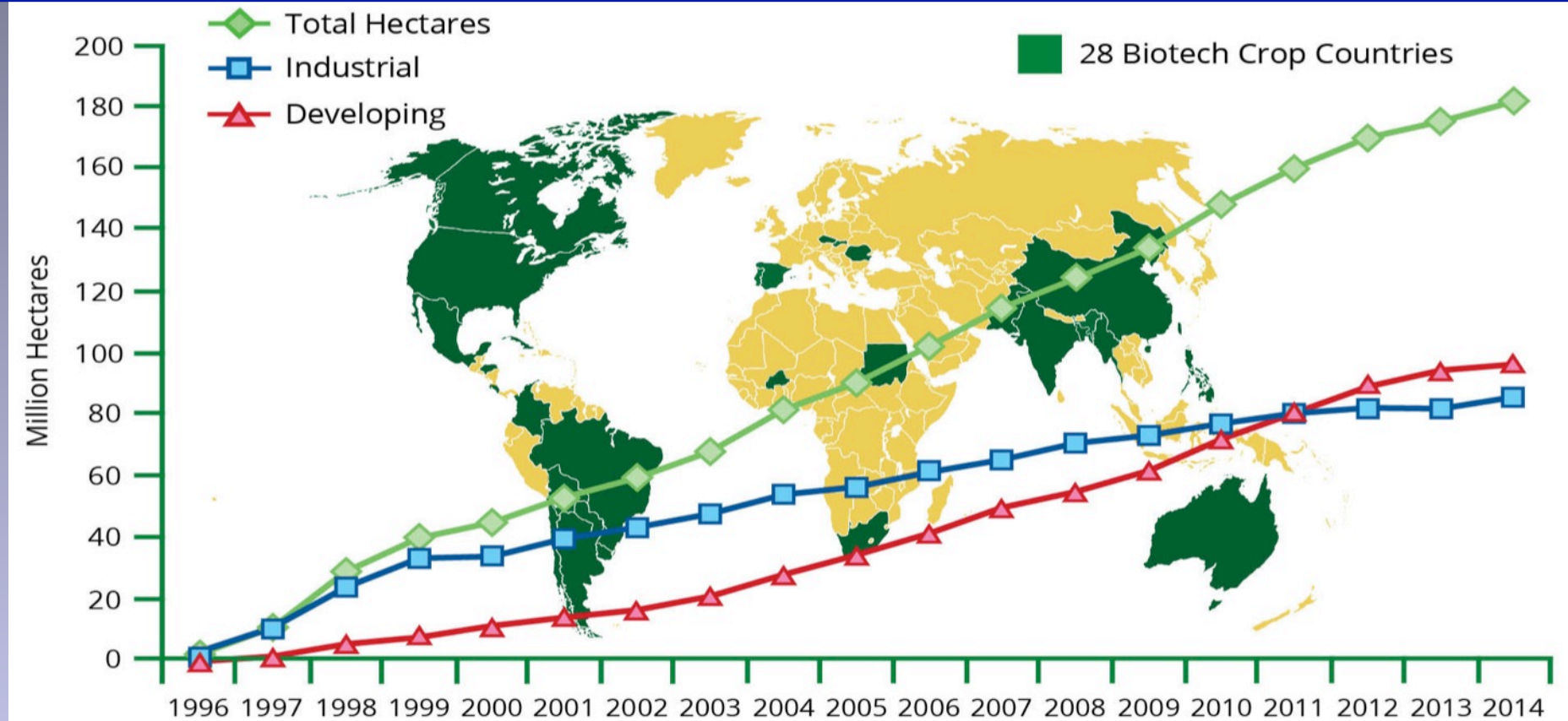


GE Squash



GE Papaya

What about worldwide? Despite limited crop and trait types, acreage is increasing in 20 developing, 8 developed countries



**2014: 18 million farmers in 28 countries planted
448M acres (>4X size of California)
>90% small acreage farmers in developing countries**



But What Kinds of GE Crops and Foods Have Been Created by GE But Are Not in the Market?

Arcadia Biosciences developing canola that uses 50% less nitrogen fertilizer

SOURCE: http://archives.foodsafety.ksu.edu/agnet/2007/4-2007/agnet_april_10.htm#story0



UCD researcher engineers drought tolerance: results in vigorous growth after prolonged drought



Tobacco after 2 weeks without water then 1 week watered

Control, non-engineered



Engineered tobacco

SOURCE: Rivero, R.M., Kojima, M., Gepstein, A., Sakakibara, H., Mittler, R., Gepstein, S. and Blumwald, E. 2007. Delayed leaf senescence induces extreme drought tolerance in a flowering plant. Proceedings of the National Academy of Sciences USA 104: 19631-19636.

E.U. scientists create potato with gene from wild relative that protects against late blight disease, cause of Irish potato famine





American chestnut making comeback using engineered wheat gene, which destroys toxic oxalic acid that kills trees

Coghlan A. 2014. New Scientist "American Chestnut Set for Genetically Modified Revival".



High anthocyanin purple GE tomatoes. Diets with 10% purple tomatoes increased lifespan of cancer-prone mice

Mitigating food allergies in wheat and peanut

SOURCE: Li, Y.-C., Ren, J.-P., Cho, M.-J., Zhou, S.-M., Kim, Y.-B., Guo, H.-X., Wong, J.H., Niu, H.-B., Kim, H.-K., Morigasaki, S., Lemaux, P.G., Frick, O.L., Yin, J., Buchanan, B.B. 2009. The Level of Expression of Thioredoxin is Linked to Fundamental Properties and Applications of Wheat Seeds. *Molecular Plant* 2: 430-441.



Chinese Researchers Stop Wheat Disease with Gene Editing

Researchers have created wheat that is resistant to a common disease, using advanced gene editing methods.

By David Talbot on July 21, 2014

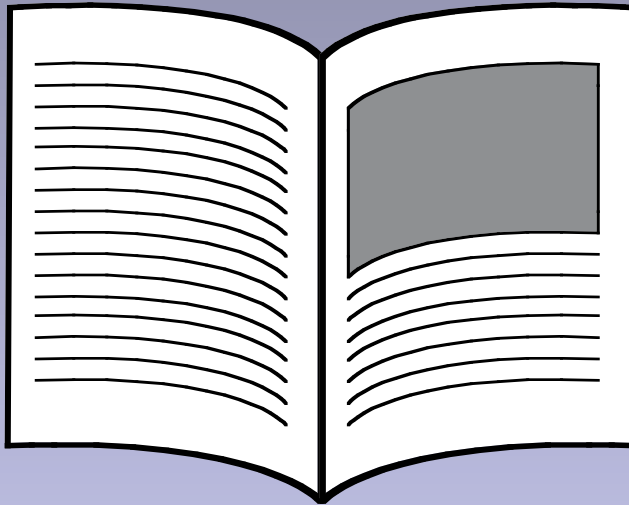
Advanced genome-editing techniques have been used to create a strain of wheat resistant to a destructive fungal pathogen – called powdery mildew – that is a major bane to the world's top food source, according to scientists at one of China's leading centers for agricultural research.



Wheat resistant to powdery mildew created using new genome-editing techniques

What is Genome Editing?

It is this one sentence which will be modified
It is that new sentence which will be modified



Find target text, cut out, paste in new modified text

1700 books
(or 1.7 million
pages)

Genome editing is not
GE or GMO

1700 books
(or 1.7 million pages)

**Inserts
specifically
in genome**

**Insert gene
edits**

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?

What are some issues with GE foods and crops?



What are some food safety issues?

- Lack of peer-reviewed food safety tests
- Labeling
- Creation of allergens or activation of toxins
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance

What are some food safety issues?

- Lack of peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- Labeling
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance

Occasionally there are widely publicized studies that cast doubt on safety of GE foods - one published by French researcher in Sept. 2012

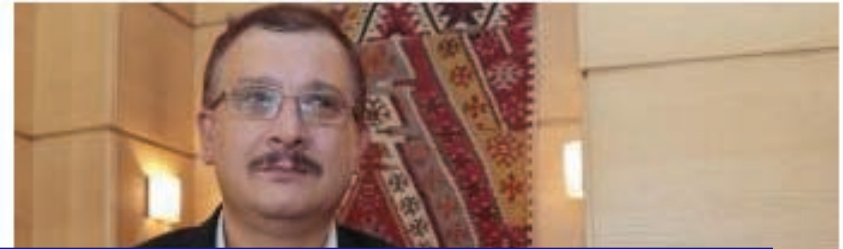
Later reviewed by European Food Safety Authority and found to have no merit

But did you ever hear that on Dr. Oz?

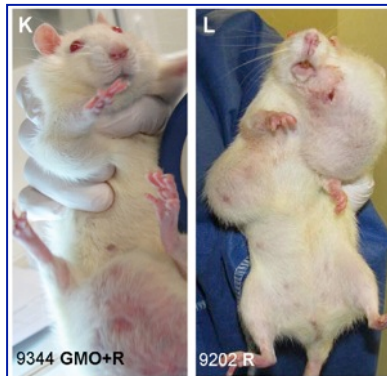
French academies trash GM corn cancer study

By RFI

A controversial study that linked genetically modified maize to cancer in laboratory rats was "not reliable" and "spread fear among the public," six French academies said in a joint statement.



Featured on Dr. Oz Show



Claim that Monsanto's RR corn causes tumors in rats



The report's author, Gilles-Eric Séralini, with his book All Guinea pigs
AFP /Jacques Demarthon

"This work does not enable any reliable conclusion to be drawn," they say, adding that the publicity surrounding the publication has "spread fear among the public."

The joint statement - an extremely rare event in French science - is unsigned and issued in the names of the national academies of agriculture, medicine, pharmacy, science, technology and veterinary studies.

What have other published studies shown?

Meta-analysis from France in 2012 showed GE foods are nutritionally equivalent to non GE foods and can be safely consumed in food and feed.

Based on 12 long-term (>90d to 2yr) and 12 multigenerational (2 to 5 generation) feeding trials of GE feed in animals



maize

potato



soy

rice



triticale

More recent meta-analysis in 2014, using publicly available sources from 1983 to 2011 tracking > 100 billion animals raised on GE feed, concluded “no unfavorable or perturbed trends in livestock health and productivity”.



SOURCE: Van Eenennaam, A.L. and Young, A.E. 2014. Prevalence and impacts of genetically engineered feedstuffs on livestock populations. Journal of Animal Science, published online on September 2, 2014, doi:10.2527/jas.2014-8124. <http://www.journalofanimalscience.org/content/early/2014/08/27/jas.2014-8124>



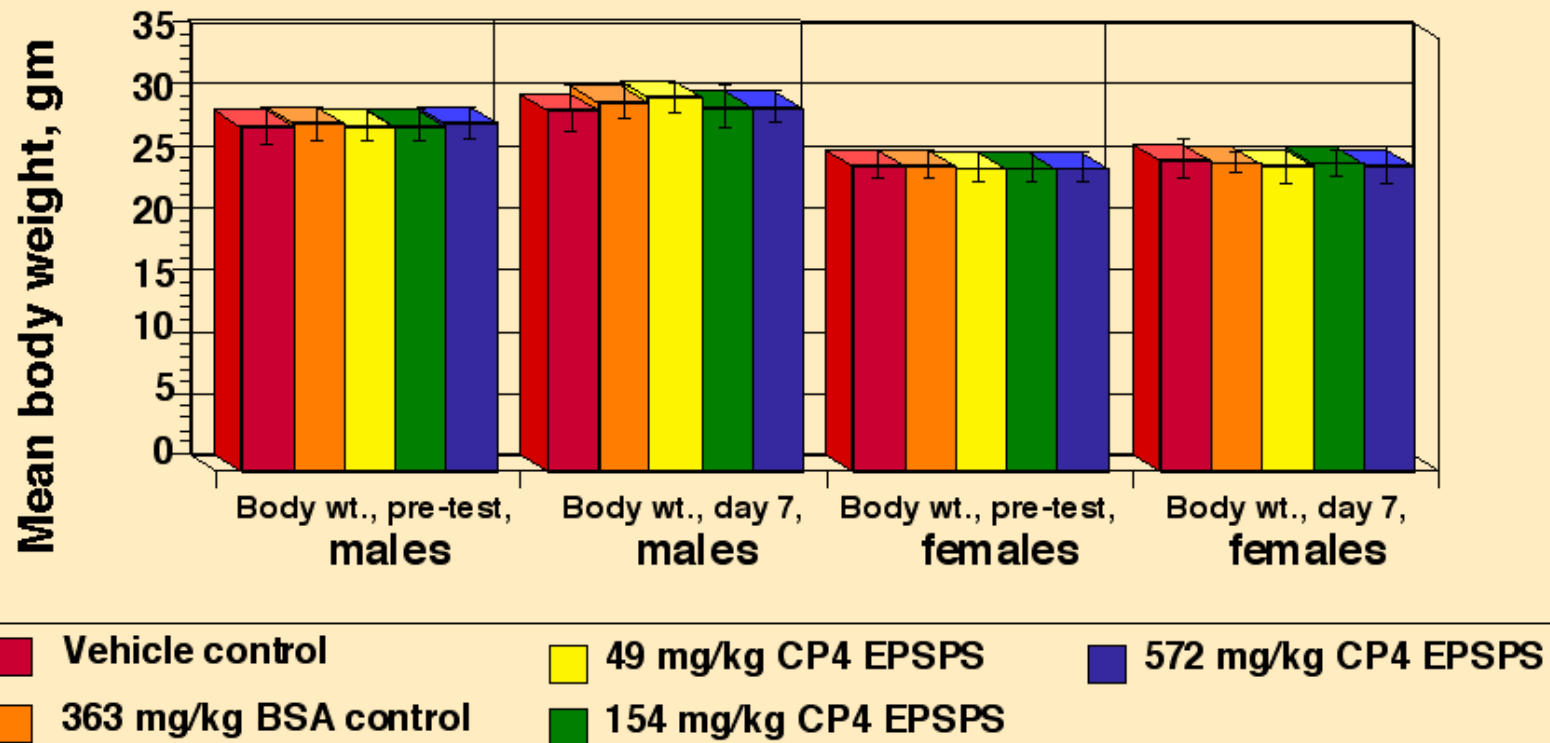
Are there allergy problems with GE foods?



- Oct 2000: StarLink *Bt* gene found in foods, causing massive recalls
- Allergic reactions claimed, but no StarLink found in food consumed
- Allergic reactions likely not due to Starlink
- No other GE foods linked to medically confirmed allergic reactions
- Allergic reactions to GE foods could occur, but not more frequently than with classically bred foods – whether conventional or organic
- Premarket checks of allergenicity of GE products

How are Toxicity Assessments on GE Foods Conducted?

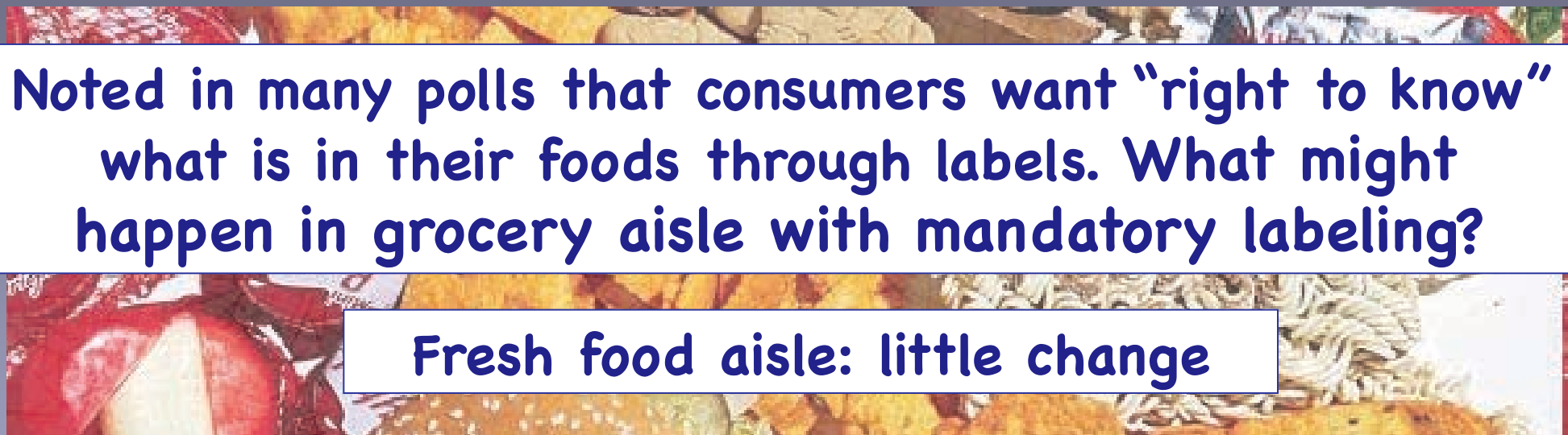
No deleterious effects at highest dose (572mg/kg)



Increasing doses of Roundup Ready gene product fed to male & female rats; body wt & other health conditions followed

What are some food safety issues today?

- Lack of peer-reviewed food safety tests
- Creation of allergens or activation of toxins
- Labeling
- Pharma crops contaminating food supply
- Gene flow from food to intestinal bacteria increasing antibiotic resistance



Noted in many polls that consumers want “right to know” what is in their foods through labels. What might happen in grocery aisle with mandatory labeling?

Fresh food aisle: little change

Processed food aisle: 75% of U.S. processed foods have GE ingredients so either alternative GE ingredients needed or most processed foods would be labeled “contain” or “may contain genetically engineered ingredients”



If the latter, consider the following...

Governor Vows to End Prop. 65 'Shake-down' Suits

by **The Downside of Prop. 65's Good Intentions**



You've seen the signs, posted everywhere from gas stations to convenience stores, warning that a site contains chemicals "known to cause cancer and birth defects."

- *Originally passed to protect CA citizens from toxic substances*
- *Prop 65 warning signs are so prevalent now that signage has become meaningless*
- *Could this happen with signage for GE foods?*

It's being abused by unscrupulous lawyers," Brown said in a press release.

Food Safety News

Breaking news for everyone's consumption

GE Labeling Resurrected in California, Petition For Ballot Measure Circulating in Colorado

BY DAN FLYNN | MARCH 25, 2014

California's 2012 food-labeling ballot measure, rejected by state voters, makes a return from the grave tomorrow with a public hearing in Sacramento. And another state initiative is in the offing in Colorado.

Since the narrow loss for the Golden State's Proposition 37, which called for labeling foods made with genetically modified organisms (GMOs), almost half the states have seen bills introduced containing similar



A number of statewide initiatives could result in patchwork of labeling laws – making it difficult for commerce and enforcement – something currently true for international commerce

SOURCE: "GE Labeling Resurrected in California, Petition For Ballot Measure Circulating in Colorado", March 25, 2014, Food Safety News.
<http://www.foodsafetynews.com/2014/03/gm-labeling-resurrected-in-california-petition-circulating-for-initiative-in-colorado/#.UznX9q1dVLM>



**Other option: non-legislative labeling efforts,
like the popular Non-GMO Project label**



SOURCE: "GMO Labeling: These Numbers Will Astound You", The Motley Fool, 2/7/15
<http://www.fool.com/server/printarticle.aspx?file=/investing/general/2015/02/07/gmo-labeling-these-numbers-will-astound-you.aspx>

SOURCE: Costanigro, M. and Lusk, J.J. 2014. The signaling effect of mandatory labels on genetically engineered food. Food Policy 49: 259-267



Another option: "USDA offers to verify food companies' claims that products contain no GMO's"

"This decision adds GE ingredients to the agency's audit program that verifies various food claims, e.g., grass-fed, antibiotic-free and humanely raised. Program is voluntary. Producers asking for non-GMO verification will pay a fee"



Clearly labeling issue is not resolved.

SOURCE: "U.S. action on GMOs stops far short of mandatory labels", San Francisco Chronicle, 5/14/15.
<http://www.sfgate.com/science/article/U-S-plan-to-vouch-for-GMO-free-foods-disappoints-6264407.php>



What are environmental and economic issues with GE crops?

- Loss of efficacy of engineered trait?
- Property rights (gene patents)?
- Regulatory issues
- Transfer of engineered genes to non-GMO/organic crops?
- Spread of pharmaceutical genes into crops?
- Loss of genetic diversity?

What are environmental and economic issues with GE crops?

- Loss of efficacy of engineered trait?
- Property rights (gene patents)?
- Regulatory issues
- Transfer of engineered genes to non-GMO/organic crops?
- Spread of pharmaceutical genes into crops?
- Loss of genetic diversity?

Insect Resistance

B.t. cotton and corn engineered for insect resistance with gene(s) from naturally occurring bacterium.

*Worry was that insects would develop resistance to B.t.
After 20 years only minimal resistance has occurred*

But what about negative impact of Bt corn pollen on monarchs. Research in late 1990's found effects to be minimal, but...

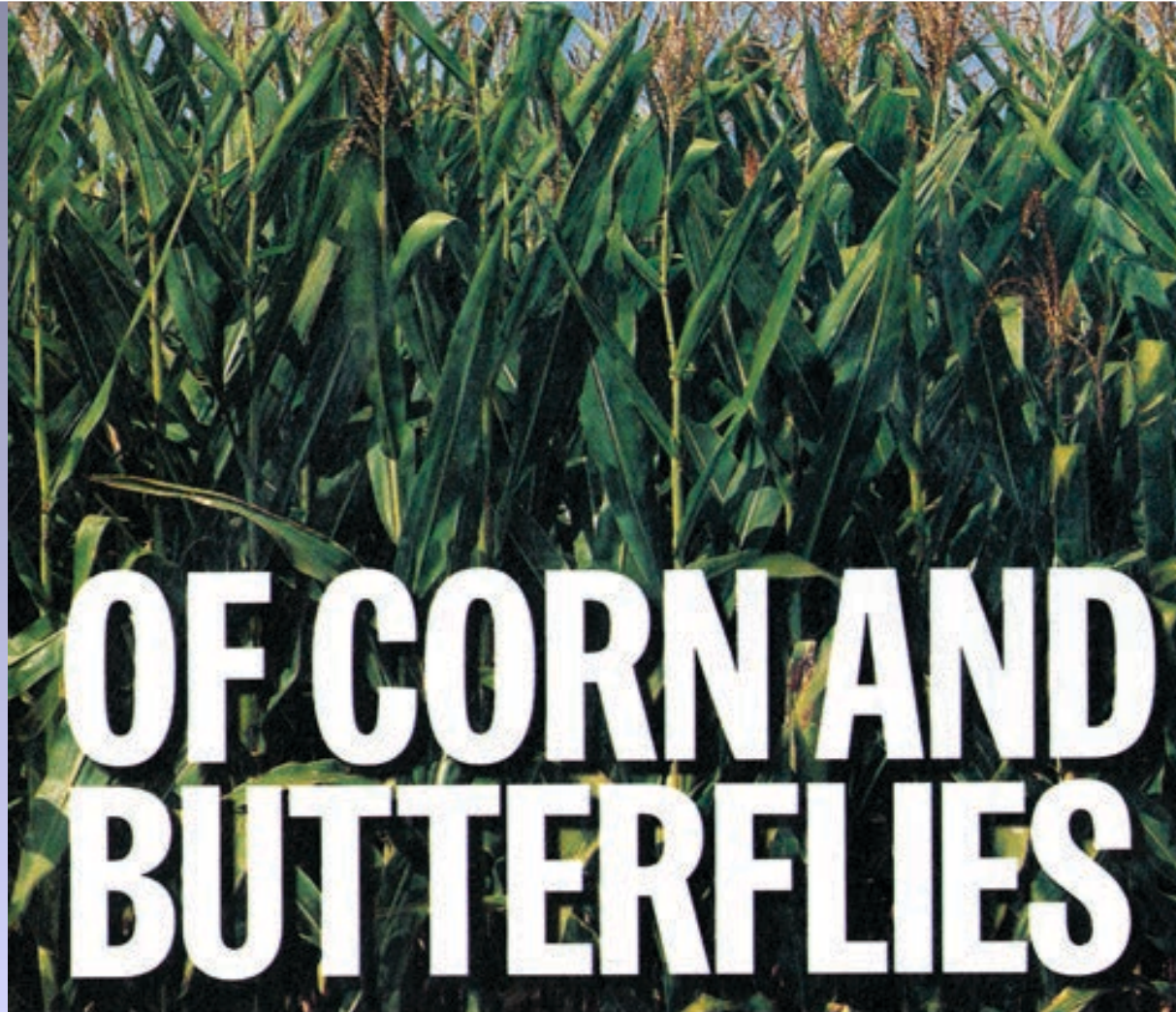


Image from Time, May 31, 1999, p. 80

Groups seek glyphosate limits to protect butterflies

By MATEUSZ PERKOWSKI
Capital Press

Environmental groups seeking federal protection for monarch butterflies blame the use of genetically modified crops for the insect's steep decline.

Petitioners claim that while there were as many as 1 billion monarchs as recently as the 1990s, their numbers have dropped to around 33 million.

If the U.S. Fish and Wildlife Service agrees to list the species as threatened or endangered, protecting the insect may involve pesticide restrictions that affect biotech crops.

The alleged link between transgenic crops and the drop in monarch butterfly populations is milkweed, a plant that monarch larvae feed upon exclusively.

"A primary threat to the monarch is the drastic loss of milkweed caused by increased and later-season use of the herbicide glyphosate in conjunction with widespread planting

of genetically engineered corn and soybeans in the Corn Belt region of the United States and to planting of genetically engineered cotton in California," the environmentalist petition said.

In the past, many herbicides had trouble killing milkweed because it's a perennial that regenerates from its roots, said Bill Freese, science policy analyst for the Center for Food Safety, a non-profit involved in the petition.

Glyphosate, on the other hand, is absorbed by the plant's roots and destroys it completely, he said.

After glyphosate-resistant biotech crops became common in the 1990s, farmers began spraying much more of the herbicide, Freese said.

They also applied it after crops had begun growing, rather than killing weeds before the crops emerged — the effect was that milkweed was already sprouting and susceptible to the chemical, he said.

"Timing is also a factor," Freese said.

While several types of aggressive weeds have developed resistance to glyphosate due to frequent spraying, hundreds have not, including milkweed, he said. "Each weed is really different."

If the federal government extends Endangered Species Act protection to the monarch butterfly, the listing could result in restrictions on how often glyphosate and other herbicides can be used on crops, Freese said.

As a consequence, farmers may plant fewer acres of genetically engineered crops, since they wouldn't be able to spray the chemicals over the top of crops in certain fields, he said.

The Biotechnology Industry Organization, which represents biotech companies, would not comment on the petition or the effect of transgenic crops on milkweed and monarchs.

Farmers can play a key role in the recovery of the species, said Sarina Jepsen,

endangered species program director for the Xerces Society, an environmental group involved in the petition.

"We've seen real leadership from the agricultural sector in restoring habitat for the monarch butterfly," Jepsen said.

If the insect is listed as threatened, the Fish and Wildlife Service could enact 4(d) Special Rules that would allow routine farming practices to continue as long as they don't contribute to the insect's extinction, she said.

Jepsen said she didn't want to speculate about impacts to agriculture at this point, but she said 4(d) rules have been proposed for another butterfly species, the Dakota skipper, which the agency has proposed listing as threatened.

Under those rules, grazing would be disallowed in certain counties in Minnesota and North Dakota and farmers would face restrictions on when they can cut grass for hay.

...another GE trait (RoundupReady) causes negative impact on milkweed - exclusive feedstock for butterfly larvae

SOURCE: "Groups seek glyphosate limits to protect butterflies", Capital Press, September 3, 2014
http://www.capitalpress.com/Nation_World/Nation/20140903/groups-seek-glyphosate-limits-to-protect-butterflies





Herbicide Tolerance

**Environmental impact associated with herbicide use,
measured by the Environmental Impact Quotient, fell by 17.1%**

But is there a consequence?

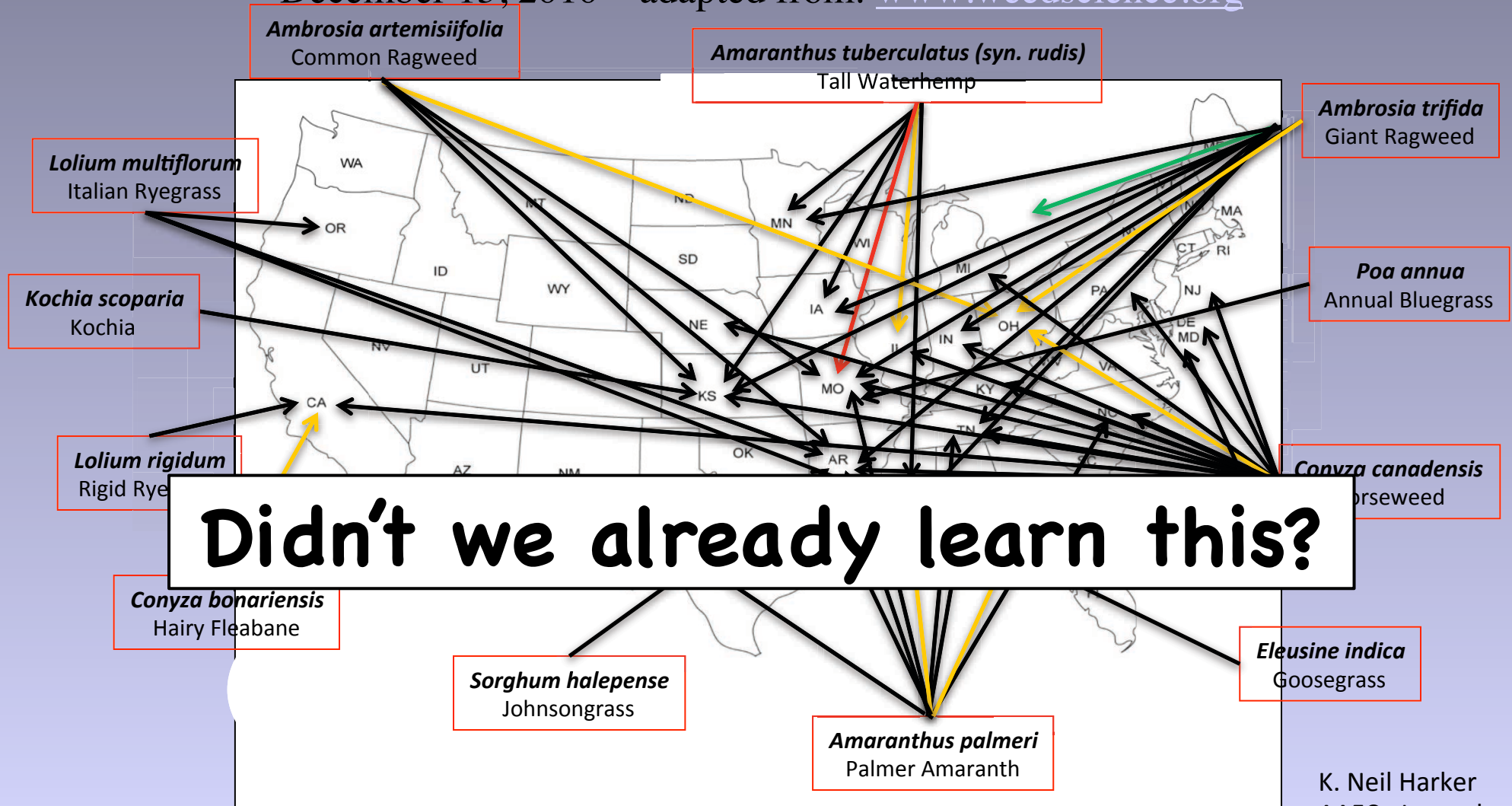
Herbicide-resistant Weeds Threaten Soil Conservation Gains: Finding a Balance for Soil and Farm Sustainability

“When any single herbicide mechanism of action is used repeatedly without alternative management tactics, selection pressure becomes intense for plants that are tolerant or resistant to that herbicide.”

SOURCE: Council for Agricultural Science and Technology (CAST). 2012. Herbicide-resistant Weeds Threaten Soil Conservation Gains: Finding a Balance for Soil and Farm Sustainability. Issue Paper 49. CAST, Ames, Iowa. <http://bit.ly/2w0AXOq>

Numbers of glyphosate-resistant weeds exacerbated when same herbicide is used repeatedly

December 13, 2010 – adapted from: www.weedscience.org



Didn't we already learn this?

K. Neil Harker
AAFC - Lacombe, AB



What are environmental and economic issues with GE crops?

- Loss of efficacy of engineered trait?
- Property rights (gene patents)?
- Regulatory issues
- Transfer of engineered genes to non-GMO/organic crops?
- Spread of pharmaceutical genes into crops?
- Loss of genetic diversity?

Investigative report

Monsanto's practices weed out competition

Licensing pacts, science

Numerous issues go beyond science and facts

- 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.

cent 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

What are environmental and economic issues with GE crops?

- Loss of efficacy of engineered trait?
- Property rights (gene patents)?
- Regulatory issues
- Transfer of engineered genes to non-GMO/organic crops?
- Spread of pharmaceutical genes into crops?
- Loss of genetic diversity?

USDA APHIS' OVERSIGHT QUESTIONED

"Recent discoveries indicate that APHIS' test plot safeguards are not reliable"

San Francisco Chronicle

GMO experiments receive questionable oversight

Bill Lambrecht

Updated 7:57 am, Monday, September 8, 2014



Washington -- At a secret location among the vineyards of California's Central Coast, a plot of genetically engineered corn is producing proteins for industrial and pharmaceutical uses, including an experimental vaccine for hepatitis B.

The altered corn is growing with federal approval 100 feet from a steelhead stream in San Luis Obispo County, in designated critical habitat for the threatened California red-legged frog. Agriculture Department inspectors have reported two "incidents" at the site, including conventional corn sprouting in a 50-foot fallow zone, but the findings did not rise to the level of a fine or even to a formal notice of noncompliance for the company that planted it, Applied Biotechnology Institute Inc.

Details of Applied Biotechnology's inspections and hundreds of other field trials with genetically modified plants were obtained by Hearst Newspapers under Freedom of Information laws. The inspection reports and other Agriculture Department records present a picture of vast, swiftly expanding outdoor experimentation and industry-friendly oversight of those experiments.

Applied Biotechnology
grows GE corn with
industrial/pharmaceutical
proteins in San Luis Obispo
– violating APHIS
regulations – minimal to no
retribution.

SOURCE: "GMO experiments receive questionable oversight", San Francisco Chronicle, September 8, 2014
<http://www.sfgate.com/default/article/GMO-experiments-receive-questionable-oversight-5740478.php#photo-3350249>



Methods changed to avoid USDA oversight



Obligate outcrosser - tall fescue

USDA clears GMO tall fescue



Mateusz Perkowski
Capital Press

Published:
December 30, 2014 9:21AM

Last changed:
December 30, 2014 9:28AM

A new GMO variety of tall fescue turfgrass that's resistant to glyphosate herbicides has been cleared for cultivation by USDA.

The USDA has cleared the way for cultivation of genetically modified tall fescue without conducting an environmental review of the new crop.

The Scotts Miracle-Gro company developed the glyphosate-resistant turfgrass variety with genes

No USDA environmental review of GE turfgrass because GE did not involve use of plant pest or parts from plant pest

authority to regulate the tall fescue, according to a document recently released by the agency.



Downside: New methods may avoid regulatory rules
“Crops are being created...using techniques that...use new methods, like “genome editing”, that were not imagined when regulations were created.”

Upside: “Freedom from oversight could open opportunities for smaller companies and university breeders and for the modification of less common crops.”

SOURCE: “By ‘Editing’ Plant Genes, Companies Avoid Regulation?”, New York Times, January 1, 2015.. <http://nyti.ms/1rGRAIq>




Where to get
more
information on
the issues?

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 ▼

knowGMOS

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.




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 guides.


HELPFUL SITES

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

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.



ucbiotech.org

