



GE Crops - IPM Benefit or Barrier?

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<http://nature.berkeley.edu/lemauxlab>





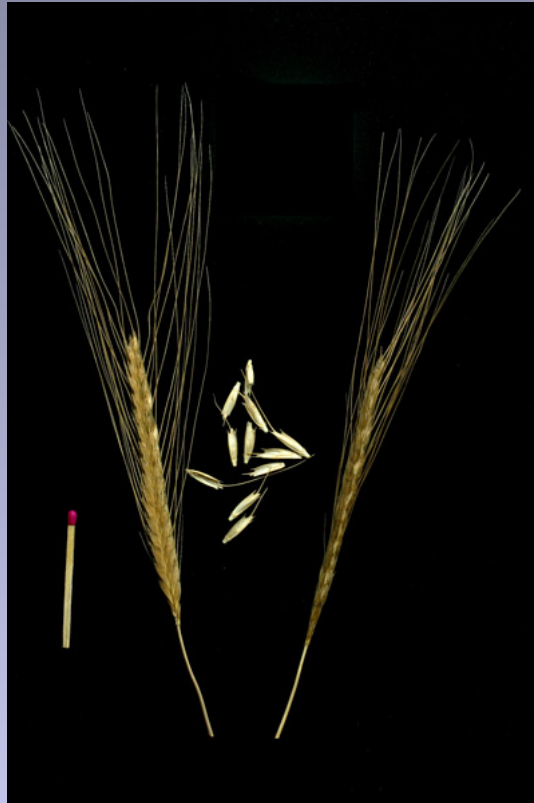
Background on genes, genetics and genetic modification (aka biotechnology, GMOs)

What engineered (GM) crops have been commercialized? What's in the pipeline?

What is regulatory structure for GE crops?

What are some issues with GE crops?

How are genes and chromosomes modified to create new plant varieties by classical breeding?



Triticum monococcum

Ancient variety



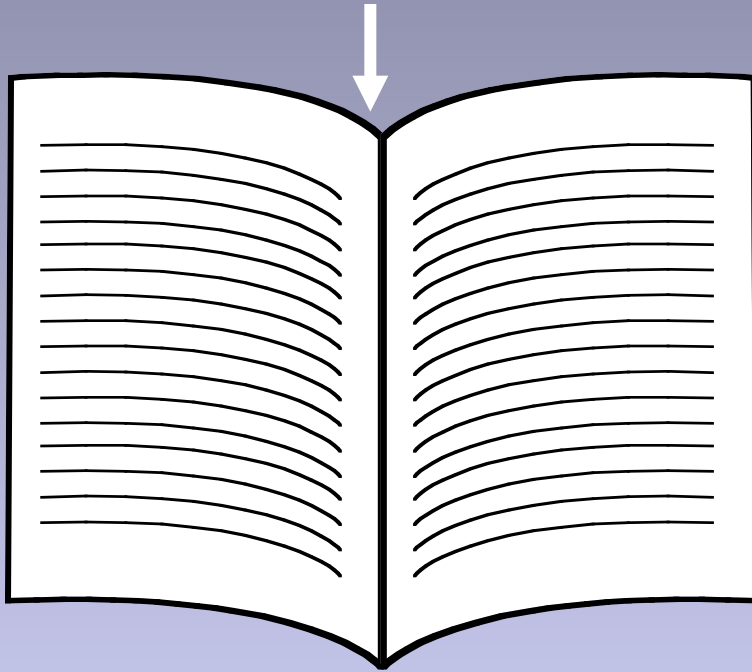
Triticum aestivum

Modern bread variety

Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...

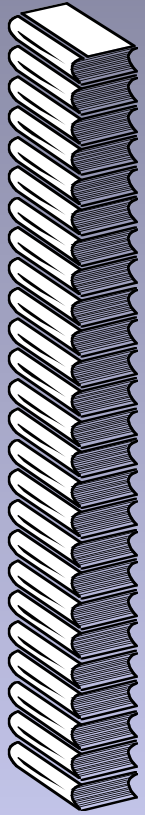


1700 books
1000 pages each

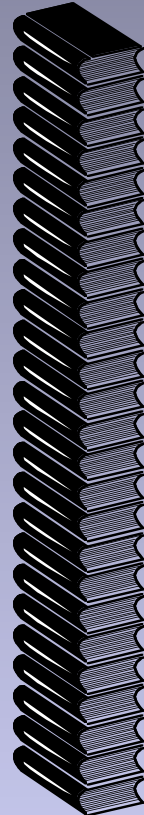


1700 books
(or 1.7 million pages)

Hybridization or cross-breeding of wheat



X



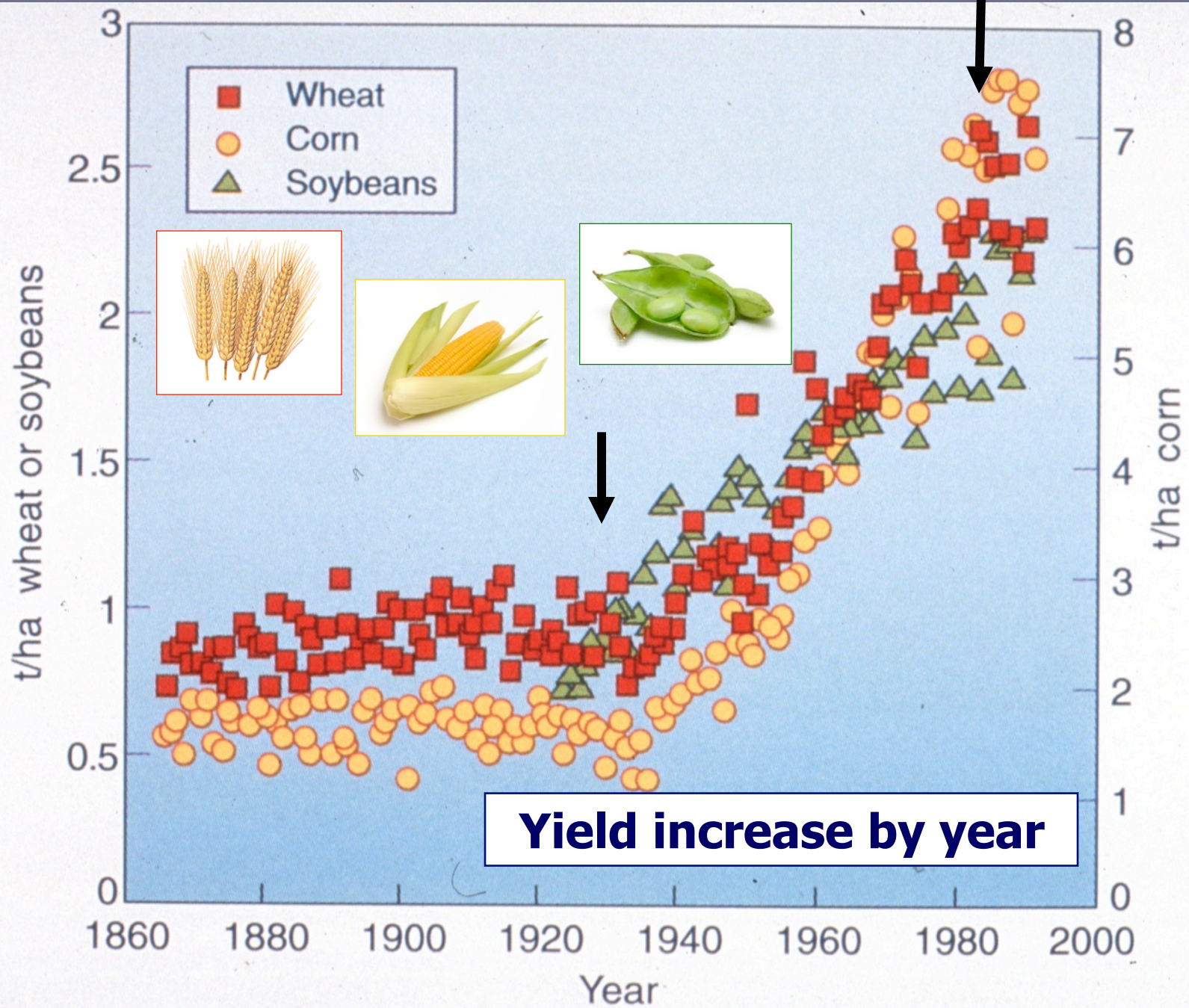
Random
retention of
~50% of
information
from each

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

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

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

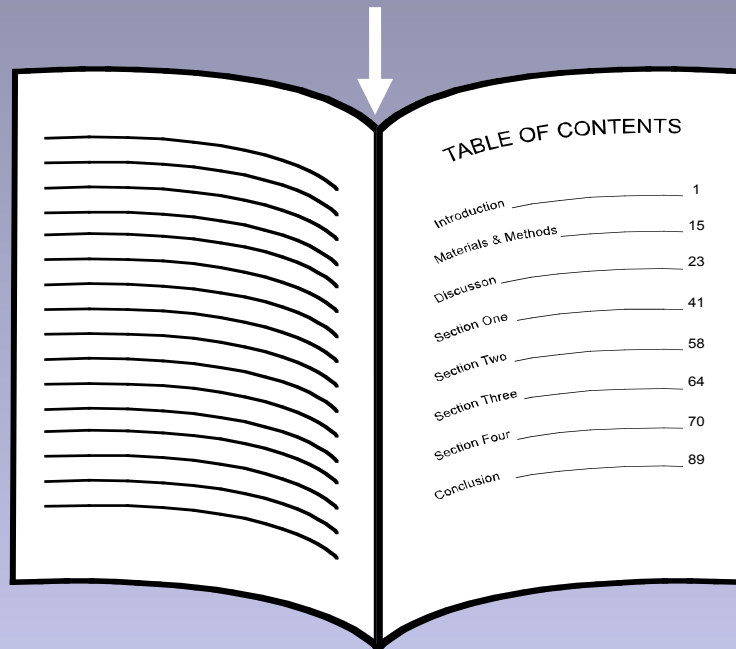
**1700 books
(or 1.7 million pages)**



There are new ways to do breeding...

Using table of contents of genes for
marker assisted selection

...CTGACCTAATGCCGTA...



Increases
speed of
breeding
process

1700 books
(or 1.7 million pages)

**Genetic modification that
is not GE or GMO**



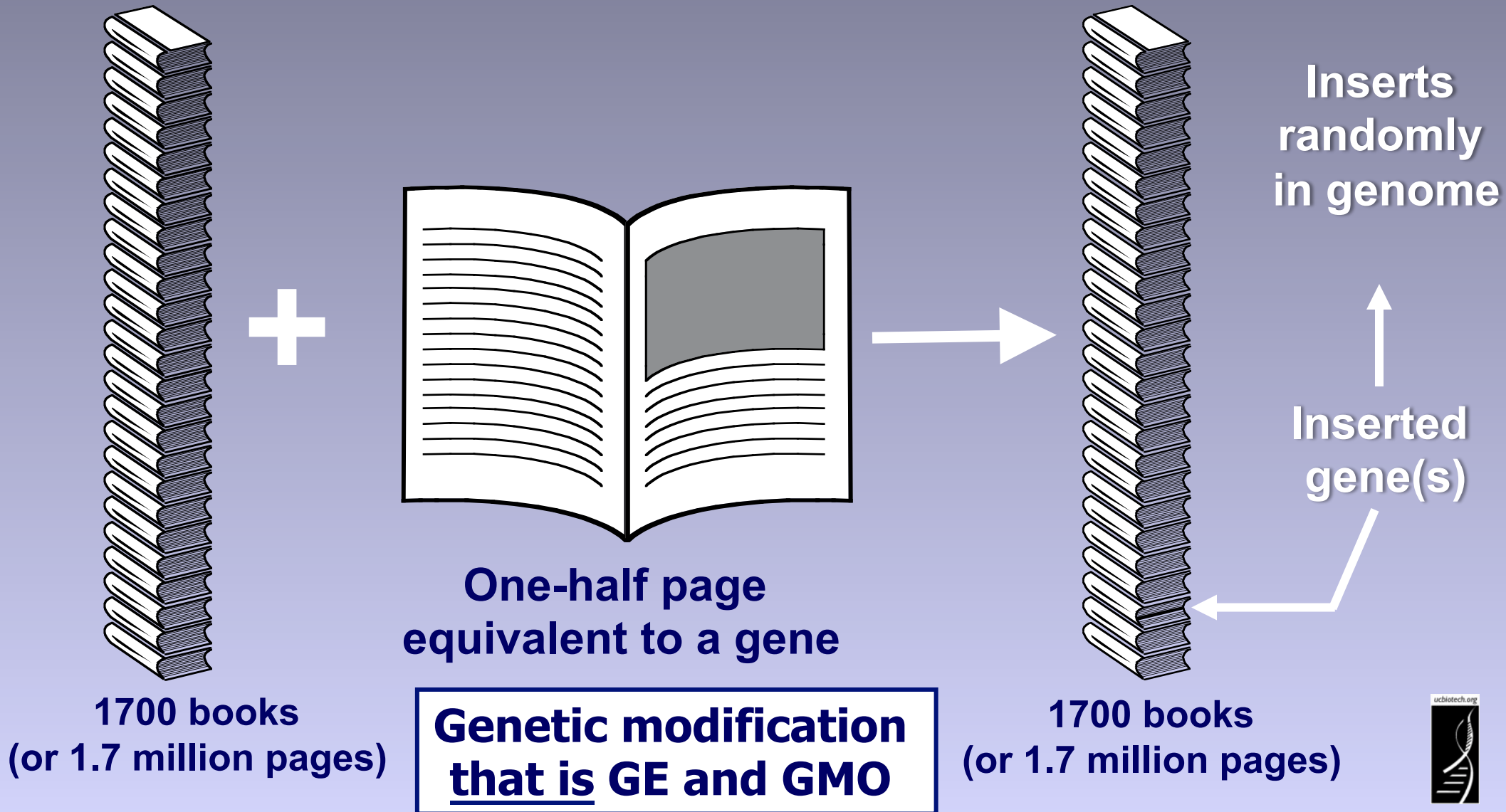
Marker-assisted selection used to protect rice against bacterial blight and blast disease

Limited to diversity in crop and compatible relatives



**But there are other ways to create
new varieties using the modern
tools of genetics**

Genetic Engineering Methods



What's the Process?

How Do You Prepare the Half Page of Information To Introduce into Plants?



On switch

Gene of interest

Off switch

Marker

On switch: controls when and where gene product is made

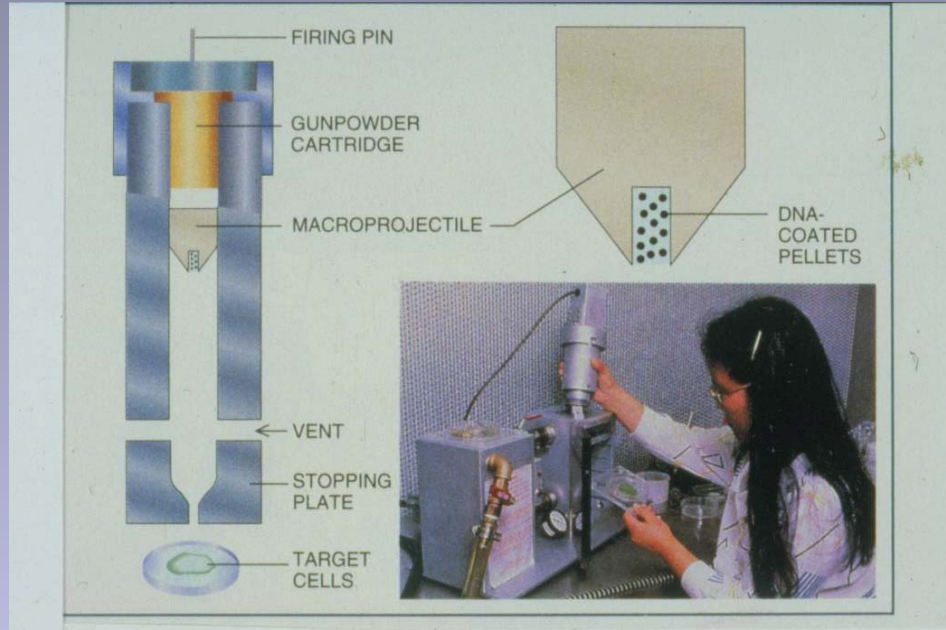
Off switch: turns off production of gene product

Gene of interest: gene of interest you want to put into the plant

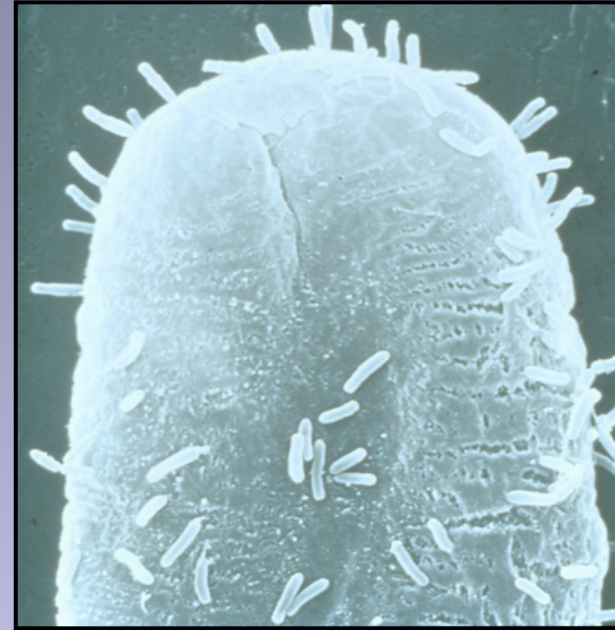
Marker: Indicates which plants have the gene of interest;
antibiotic resistance, sugar usage

What's the Process?

How Do You Introduce the Half-page into Plants?



Gene gun




Agrobacterium

Both methods introduce DNA into genetic information in plant cells

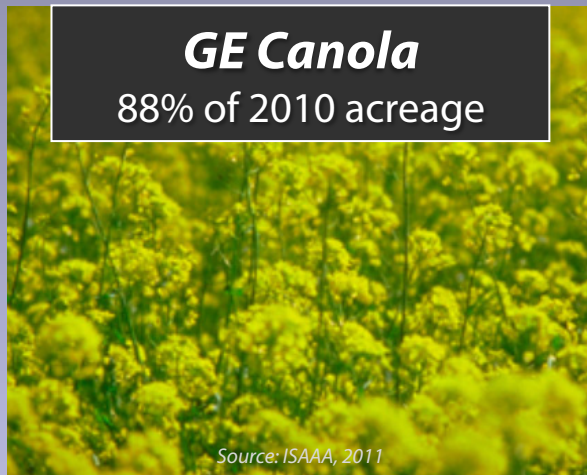
**Number of
different
commercially
available GE crops
is limited**

GE Cotton
90% of 2013 acreage
(Insect Resistant: 8% Herbicide tolerant: 15% Stacked gene: 67%)



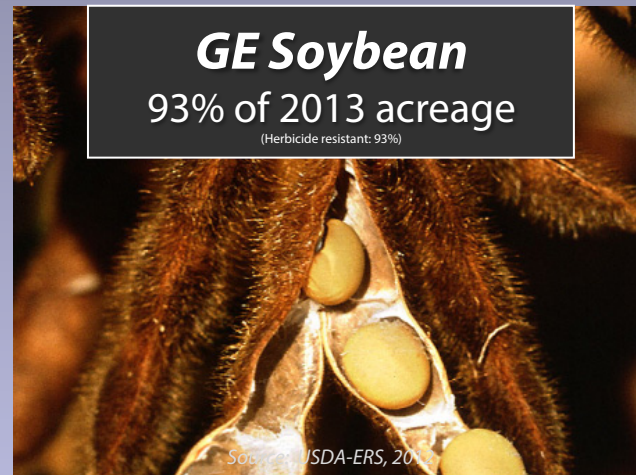
Source: USDA-ERS, 2013

GE Canola
88% of 2010 acreage



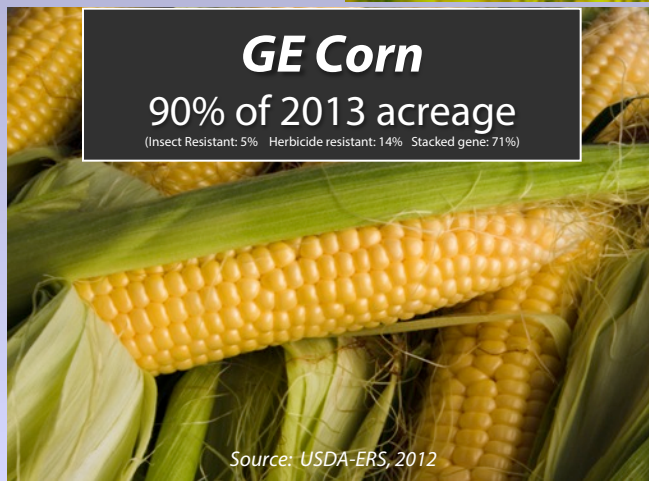
Source: ISAAA, 2011

GE Soybean
93% of 2013 acreage
(Herbicide resistant: 93%)



Source: USDA-ERS, 2013

GE Corn
90% of 2013 acreage
(Insect Resistant: 5% Herbicide resistant: 14% Stacked gene: 71%)



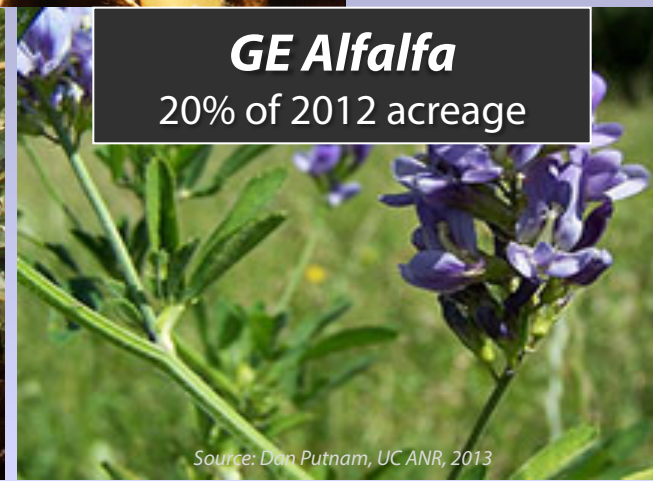
Source: USDA-ERS, 2012

GE Sugarbeet
96% of 2010 acreage



Source: ISAAA, 2011

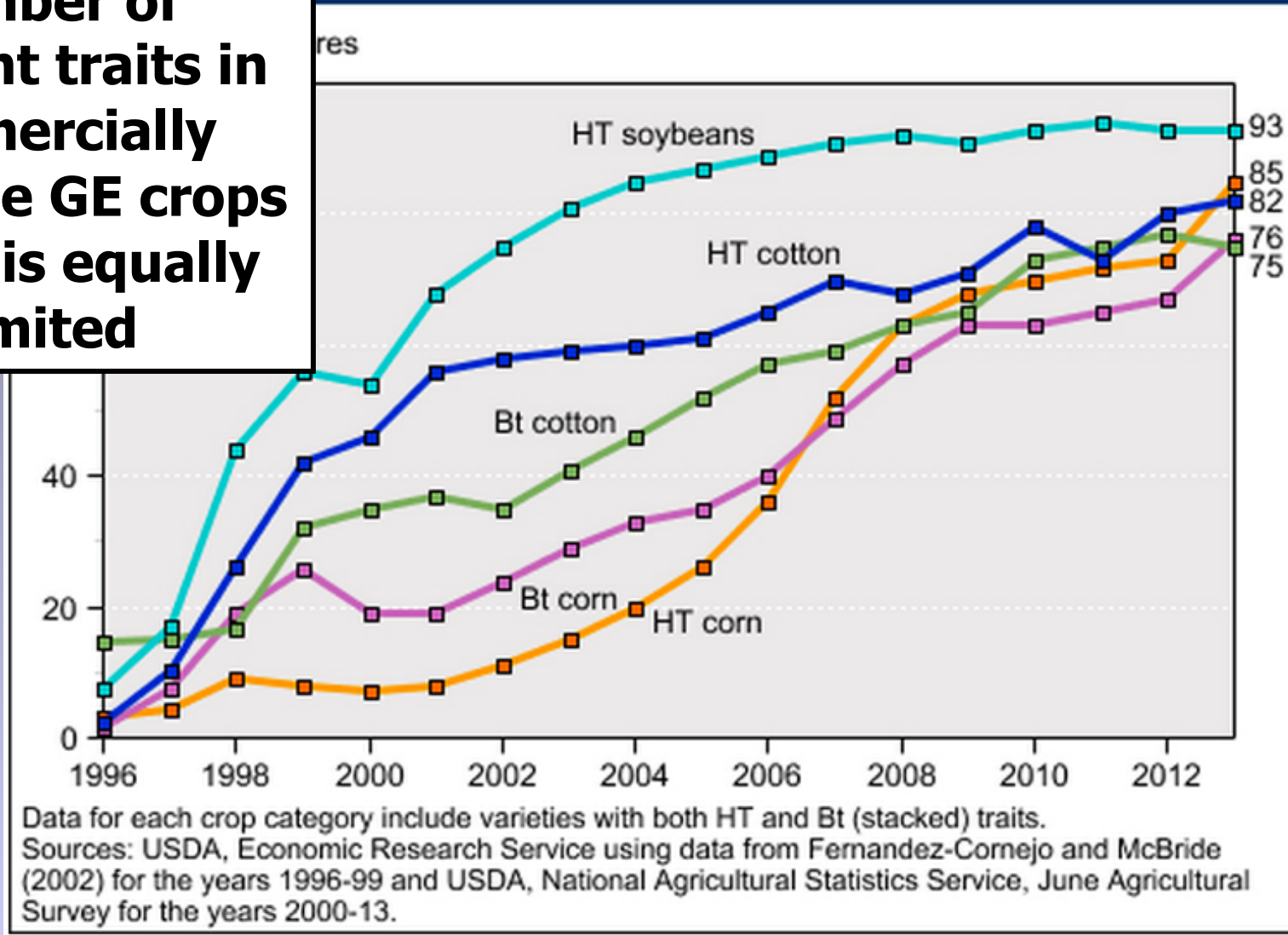
GE Alfalfa
20% of 2012 acreage



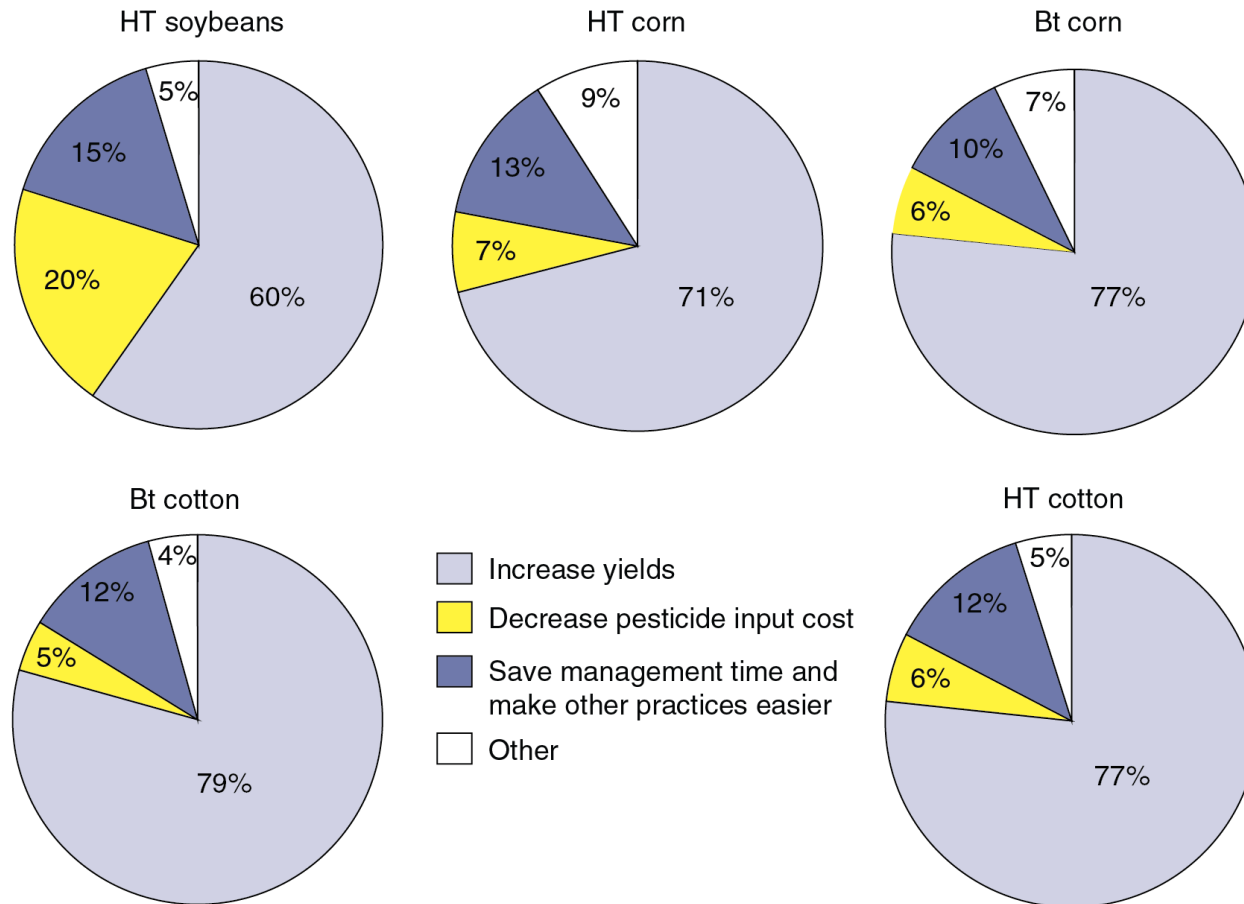
Source: Dan Putnam, UC ANR, 2013

Adoption of genetically engineered crops in the United States, 1996-2013

Number of different traits in commercially available GE crops in U.S. is equally limited



Why do growers adopt the GE crops?



Reasons vary from crop-to-crop but the predominant reason is to improve yield

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 GE crops lead to estimates that 75% of processed foods in U.S. have GE ingredients

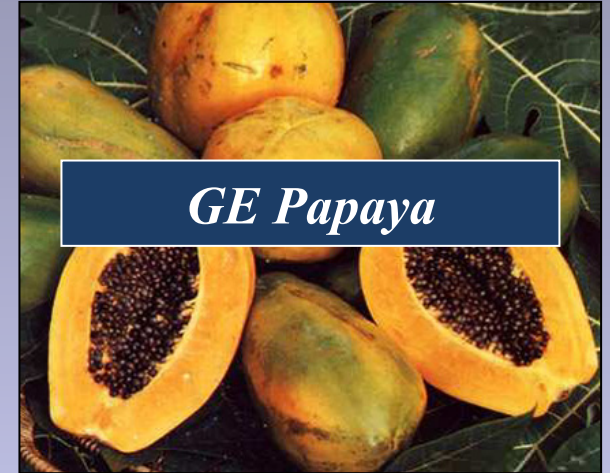
**There are only a few whole,
genetically engineered foods
in the U.S market**



GE Sweet Corn

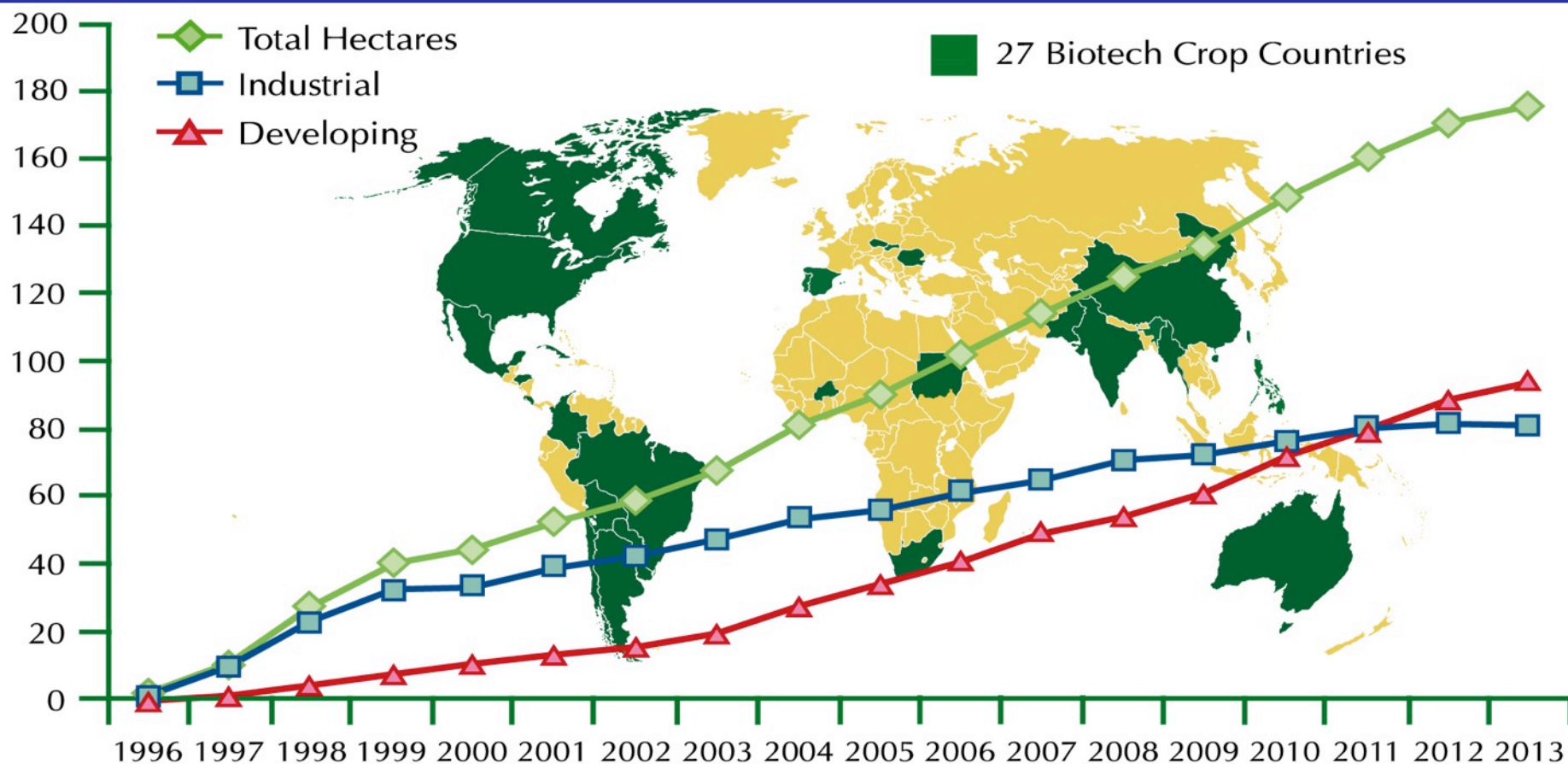


GE Squash



GE Papaya

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



2013 figures: 15.4 million farmers in 27 countries planted 433M acres (>3X size of California) >90% were small acreage farmers

WHAT'S IN THE PIPELINE?






***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



A close-up photograph of several green grapes. The grapes are covered in a fine, white, powdery substance, which is powdery mildew. The background is dark and out of focus.

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

Potato with gene from wild relative protects against late blight disease, cause of Irish potato famine



The New York Times

July 27, 2013

A Race to Save the Orange by Altering Its DNA

By AMY HARMON

CLEWISTON, Fla. — The call Ricke Kress and every other citrus grower in Florida dreaded came while he was driving.

Engineered citrus or engineered insect: to save citrus industry from losses to greening diseases

“O.K.,” he said finally on that fall day in 2005, “let’s make a plan.”

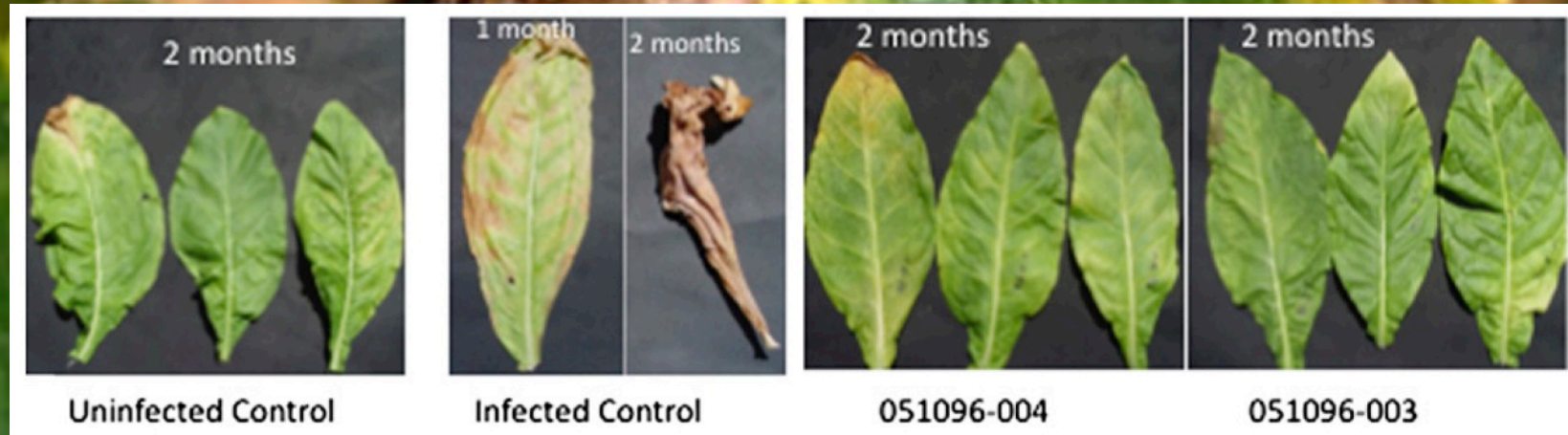
In the years that followed, he and the 8,000 other Florida growers who supply most of the nation’s orange juice poured everything they had into fighting the disease they call citrus greening.

To slow the spread of the bacterium that causes the scourge, they chopped down hundreds of thousands of infected trees and sprayed an expanding array of pesticides on the winged insect that carries it. But the contagion could not be contained.

SOURCE: “A Race to Save the Orange by Altering Its DNA”, New York Times, July 27, 2013.
<http://www.nytimes.com/2013/07/28/science/a-race-to-save-the-orange-by-altering-its-dna.html?pagewanted=all>



Modified innate protection leads to less leaf scorching and xylem clogging of grapes due to Pierce's disease



SOURCE: Dandekar, A.M., Gouran, H., Ibáñez, A.M., Uratsu, S.L., Agüero, C.B., McFarland, S., Borhani, Y., Feldstein, P.A., Bruening, G., Nascimento, R., Goulart, L.R., Pardington, P.E., Chaudhary, A., Norvell, M., Civerolo, E. and Gupta, G. 2012. An engineered innate immune defense protects grapevines from Pierce disease. PNAS 2012 109: 3721-3725; published ahead of print February 21, 2012, doi:10.1073/pnas.1116027109.





Chestnuts engineered with wheat gene, which destroys toxic oxalic acid and prevents cankers

<http://www.newscientist.com/article/dn25644-american-chestnut-set-for-1#.U5u5mJRdVW8>

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.

Advanced genome-editing techniques used to create wheat resistant to powdery mildew

What is the U.S. regulatory process that governs these engineered plants?

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
- ✓ Cotton - HT, IR
- ✓ Corn - HT, IR, AP
- ✓ Soybean - HT, PQ
- ❖ Potato - IR, VR
- ❖ Tomato - PQ
- Squash - VR
- ✓ Canola – HT
- Papaya - VR
- ❖ Rice – HT
- ❖ Rapeseed - HT, AP, PQ
- ✓ Sugar beet - HT –removed/
reinstated
- ❖ Flax – HT
- ❖ Chicorium – AP
- ❖ Tobacco – PQ
- ❖ Rose - PQ
- ✓ Large-scale production
- ❖ Not on market

(http://www.aphis.usda.gov/brs/not_reg.html)



What Are Some Issues with GE Crops?



What are some issues with GE crops?

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

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COURTS CHALLENGE APHIS

*RR sugar beets deregulated then challenged.
U.S. Circuit Court denies lawsuit to prevent
growers from planting. Environmental Impact
Statement published; deregulation reinstated 2012*

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



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OUR VIEW

APHIS needs to bolster its monitoring of GMO tests

The USDA's Animal and Plant Health Inspection Service documents reveal: "discrepancies" in the final trial plots and the resulting seed is lax. believes the enhanced inspections are

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

troubling is what investigators did find — additional instances of genetically modified wheat turning up where it shouldn't be, and proof that the agency's test plot safeguards are unreliable.

USDA's final report and the 13,000 pages of related

survived three separate applications of the herbicide, the farmer hand-picked the plants and burned them without sending them for genetic testing.

- Investigators examined notifications from Monsanto for biotech wheat field trials between 1998 and 2004 and found

Monsanto and APHIS failed to discover what happened to the seeds.

When the Oregon incident came to light last year, APHIS touted the procedures developers must follow to safeguard test plots.

But our reporting confirmed the USDA's oversight of biotech test

field trial sites.

It plans to inspect all biotech wheat field trial sites in 2014 to ensure volunteers are removed, as well as "strategically selected sites" from field tests that occurred in 2012 and 2013 in multiple states.

The Center for Food Safety

disposition of the product of these trials.

These extra steps might not prevent the accidental release of unapproved genetically modified material, but they would provide consumers, farmers and critics more confidence in the approval process.

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.

RECENT EXAMPLE

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>



OLD METHODS CHANGED TO AVOID USDA OVERSIGHT RULES



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 APHIS environmental review of GE tall fescue turfgrass because engineering did not involve use of plant pest or parts from plant pest

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.”

“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>



POSSIBLE EXAMPLE

RNAi Biotechnology: Pros and Cons for Crop Improvement

Vicki Vance, University of South Carolina, vvance@mailbox.sc.edu

Risk Assessment

microRNAs (miRNAs). The siRNA pathway engineered to produce a transgene in which

New method: Use RNAi to initiate destruction of other RNA's, which code for target proteins

required before commercial release of GM crops in all countries where these crops are currently grown, including the United States. The majority of approved GM crops have been transformed to produce one or more

pathway that is used to control an organism's own gene expression (Vazquez et al., 2010). Once produced, the small RNA (either siRNA or miRNA) incorporates into a protein complex called RISC, where it serves as a

et al., 2008). This approach produces a single small RNA rather than a population of small RNAs. The miRNA approach may be less effective in silencing the target gene (because only one small RNA is produced rather than

RNAi uses: modify oil content, increase lysine, reduce caffeine, create viral resistance

Positive: GE plants produce novel RNAs rather than proteins.

Negative: Safety concern that some RNAi's are taken up by humans when they eat plants.

ancient and modern versions of these

traits in crop plants. The approach has

What are some issues with GE crops?

- What are some regulatory issues?
- **Loss of efficacy of engineered trait?**
- Property rights (gene patents)?
- Transfer of engineered genes to non-GMO/organic crops?
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Insect Resistance

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

To date minimal insect resistance has occurred

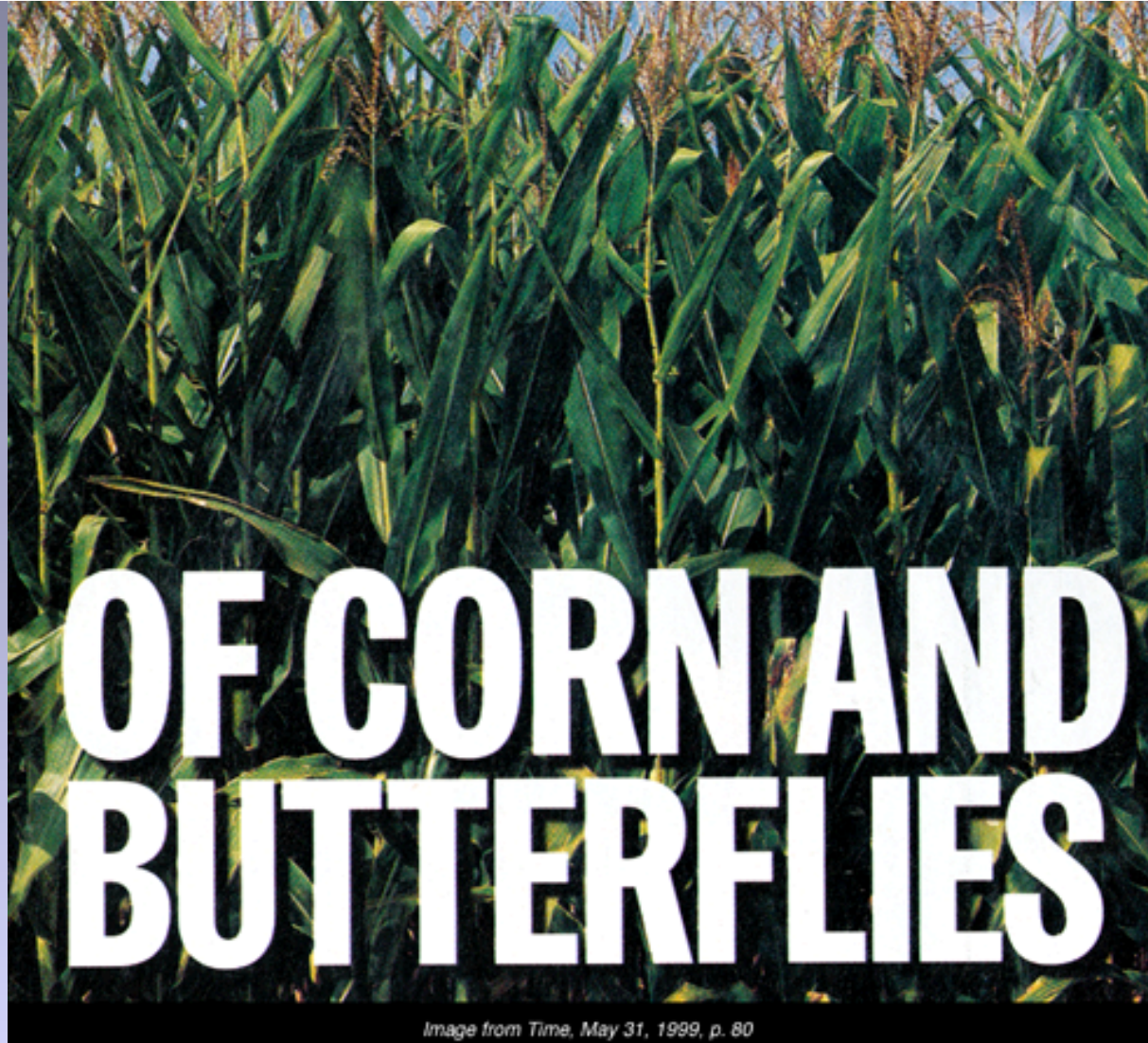
Addition of natural enemy delays pest resistance

Recent study showed that combining natural enemies, like the lady beetle, with Bt crops delays resistance development in pests"

SOURCE: Liu, X., Chen, M., Collins, H.L., Onstad, D.W., Roush, R.T., Zhang, Q., Earle, E.D. and Shelton, A.M. 2014. Natural Enemies Delay Insect Resistance to Bt Crops. PLoS ONE 9(3): e90366. doi:10.1371/journal.pone.0090366.



In late 90's negative impact of Bt corn pollen on monarchs was raised. After much research, effects were minimal, but...





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.

...Impact of RoundUp on monarchs resurfaces due to impact on milkweed – exclusive feedstock for butterfly larvae



Although Bt corn aimed at lepidopteran pests lasted with little resistance over 15 years, Bt corn targeted at rootworm beetles resulted in relatively rapid development of resistance



SOURCE: Gassmann, A.J., Petzold-Maxwell, J.L., Clifton, E.H., Dunbar, M.W, Hoffmann, A.M., Ingber, D.A. and Keweshan, R.S. 2014. Field-evolved resistance by western corn root worm to multiple *Bacillus thuringiensis* toxins in transgenic maize. *Proceedings of the National Academy of Sciences USA*, DOI: www.pnas.org/cgi/doi/10.1073/pnas.1317179111.



Causing changes in EPA's Resistance Management Plan



Revised EPA Insect Resistance Management Plan:

Monsanto agrees to changes in registration of corn rootworm products:

- ***Conduct grower education programs***
- ***Encourage crop rotation***
- ***Monitor insect susceptibility***
- ***Provide reports to EPA***



Herbicide Tolerance

Environmental impact associated with herbicide and insecticide use as measured by the EIQ indicator fell by 17.1%

But was there a consequence?

SOURCE: Brookes, G. 2012. *Genetically Engineered Crops: Environmental Impacts 1996-2009*. ISB Report, January 2012, pp. 1-5
Brookes, G. and Barfoot, P. 2011. *Global impact of biotech crops: Environmental effects 1996-2009*. *GM Crops* 2: 34-49



“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.”

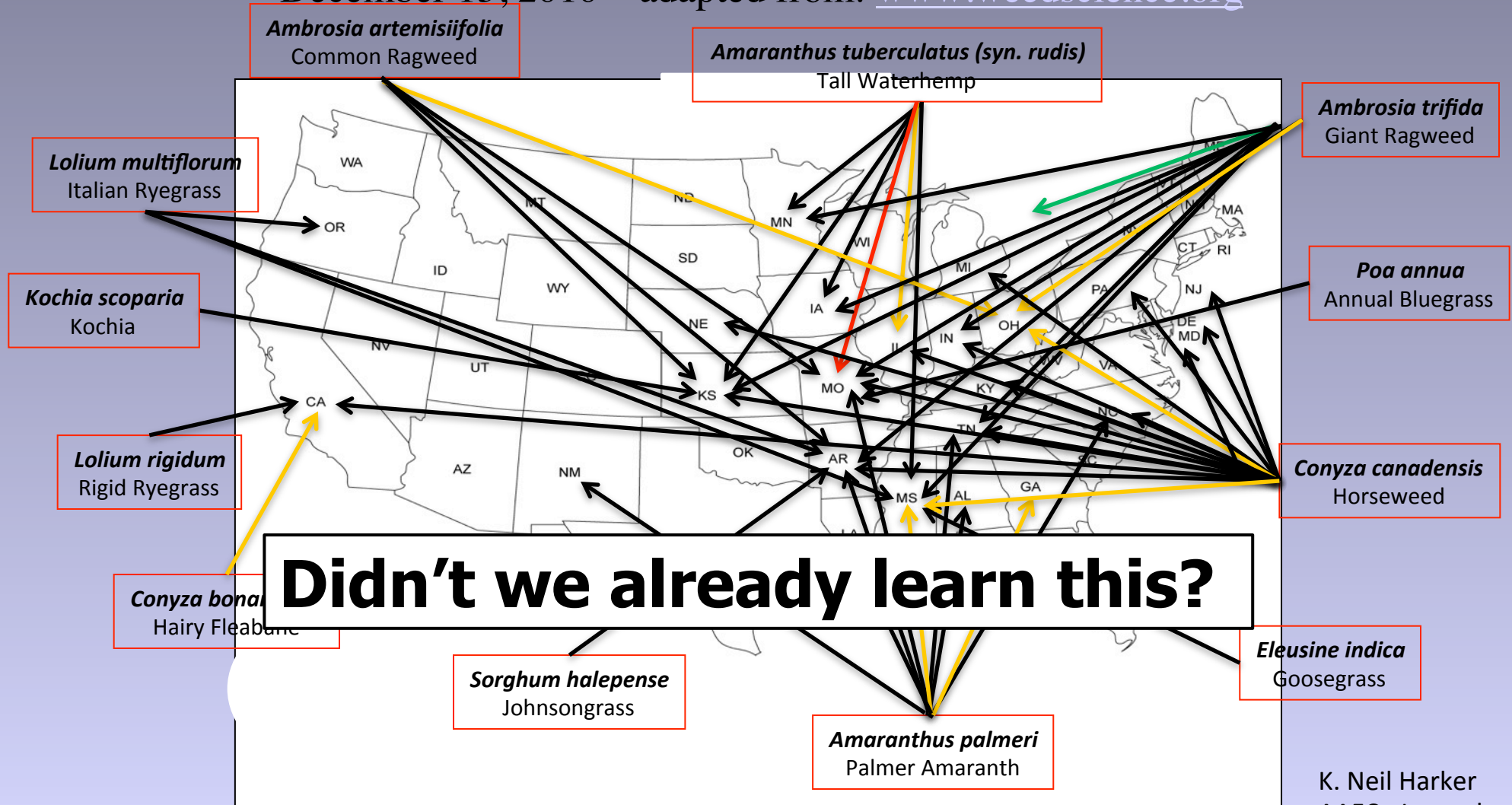
“There is now a large and growing threat to soil conservation gains because of the dire need... to manage these resistant weeds...”

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/cast49Qq>

Glyphosate-resistant weeds due to mutation, gene flow, weed shift – exacerbated when same herbicide is used repeatedly

Glyphosate- Resistant Weeds – USA

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



K. Neil Harker
AAFC - Lacombe, AB

Agency moves to approve Dow corn

2,4-D-tolerant trait would lead to more resistance, biotech critic says

Center for Food Safety non-profit group.

Freese also said he's worried about residues from 2,4-D entering the food and water supplies or harming farmwork-

New herbicides tolerances introduced to address problem, including tolerance to 2,4-D, one component of Agent Orange. AO was 50:50 mixture of 2,4-D and defoliant, 2,4,5-T, which was contaminated with dioxin.

oped by Dow Agrosciences to combat weeds resistant to glyphosate herbicides.

The agency's Animal and Plant Health Inspection Service has released a draft en-

and has evoked little concern among regulatory agencies about adverse health effects.

When asked about the potential negative effects of over-the-top application of 2,4-D,

SOURCE: Capital Press, January 5, 2012

<http://www.capitalpress.com/print/mp-other-biotech-sidebar-010612>

NEW METHODS MAY AVOID GENE FLOW

“Synthetic amino acids may allow scientists to create "genetic firewalls" that prevent GMO crops or animals from escaping and causing environmental damage”

SOURCE: “Creating a Genetic Firewall”, Los Angeles Times, January 21, 2015
<http://www.latimes.com/science/sciencenow/la-sci-sn-gmo-escape-20150121-story.html>



What are some issues with GE crops?

- ***So, Are GE Crops an IPM Benefit or Barrier?***
- **Loss of efficacy of engineered trait?**

There certainly are issues. And arguments can be made for both possible benefits and possible barriers. But in the end it will depend on how wisely we manage them.

- **Loss of genetic diversity?**


**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 ▼

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.

 **Who's In YOUR family?**

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.



ucbiotech.org



But in the end, consumers make decisions on what they buy so their opinion matters

"It's easy to see why uncertainty breeds fear. When we face a possible threat but we can't detect it with our senses, or when it's complicated and we don't understand it, or when science still hasn't answered all questions about the risk, we don't know what we need to know to protect ourselves. We feel powerless, which makes us feel more afraid."

"GMOs qualify in all three categories of uncertainty."



SOURCE: "Risky Business", Cosmos Magazine, February 2014. <http://alpha.cosmosmagazine.com/society/risky-business>.
Cited on PBS Nova website, <http://www.pbs.org/wgbh/nova/next/body/what-we-talk-about-when-we-talk-about-gmos/>



What are some issues with GE crops?

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

Investigative report

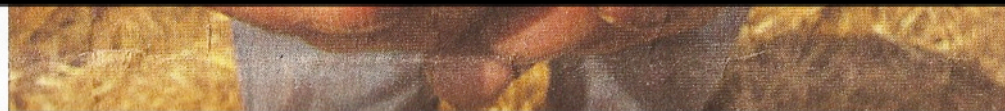
Monsanto's practices weed out competition

Licensing pacts, science propel seed company to dominate position



Companies have created today's commercial GE crops and control most key intellectual property. This makes it hard for small companies or academics to play meaningful roles in addressing agricultural challenges with GE

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

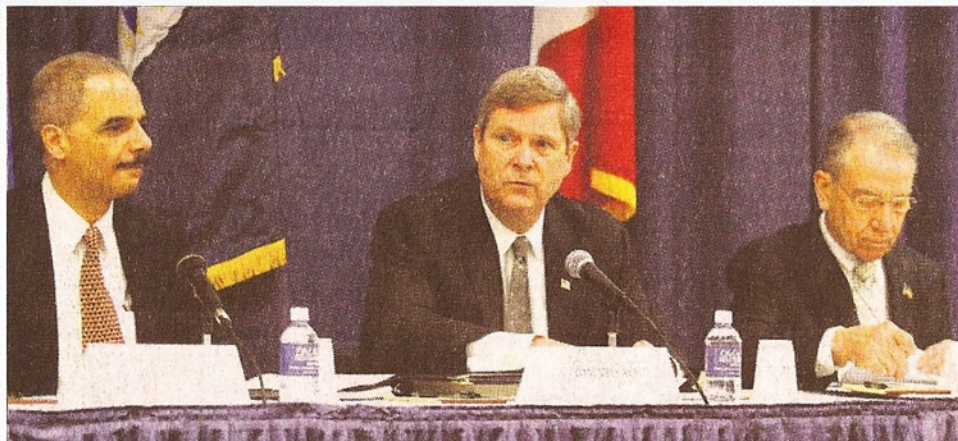
SOURCE: Capital Press, December 18, 2009

US regulators examine competition in agriculture

By CHRISTOPHER LEONARD
Associated Press

ANKENY, Iowa — Federal officials concerned about how much control a few corporations have over the nation's food supply pledged March 12 to begin a new era of antitrust enforcement, seeking to balance agricultural power between companies, farmers and consumers.

More than 650 farmers, slaughterhouse workers, lob-



Related story

See story package —
"Antitrust action looms" —
on Page 1.

brewing sense of powerless and frustration in small towns that was on display March 11 at a farmer's rally. More than 200 people packed a small ballroom and chanted: "Bust up big ag" as speakers took to the podium and told stories.

Among companies there is a lot of competition with just a few companies jockeying for position, which may or may not be good for agriculture.

then agencies.

"I think you will see an historic era of enforcement that will almost inevitably grow from the partnership that we have established," Holder said.

Some Obama administration officials have made clear

ing to discern just how aggressive the Obama administration will be.

For farmers, it is an effort to constrain corporations like Monsanto Co., Archer Daniels Midland Co. and Tyson Foods Inc., which producers say wield

ultimately result from the five hearings, which will examine competition in the dairy, seed, meatpacking and crop production.

But they said it won't just be a series of lawsuits. They're

It's clearly about the survival of rural America. We've seen a significant decline in the number of farmers and ranchers and that translates into a significant decline in the number of people living in rural America."

The hearings play to a long-

the farm sector.

"Bigger isn't per se bad," Grassley said. "But it can lead to predatory business practices and behaviors and that's what we've got to be concerned about."

What are some environmental issues?

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



**Can Organic Agriculture
Coexist with GE Crops?**

Communicate to avoid pesticide drift, winemaker says

By MATEUSZ PERKOWSKI
Freelance Writer

Fifteen years ago, David Adelsheim received some bad news. His vineyard manager had noticed that a section of his vineyard, located near Newberg, Ore., was producing vines with badly distorted leaves.

"Instead of being a full leaf shape, they might have been only half-a-leaf shape, or they were smaller and fanned together," said Adelsheim.



Is this the first time coexistence between organic and conventional agriculture has arisen?

killing the blackberries, some of the herbicide had drifted onto the rows of grapevines growing only 15 feet away.

Roughly five acres were affected by the drift, which was about a third of Adelsheim Vineyards at the time. The first several rows were the most badly damaged, but even grapevines 30 rows down were showing some deformation. Because the neighbor had sprayed in mid-spring – after the grape bud break but prior to bloom – much of the year's crop had been aborted, and the remaining vines were too damaged to ripen any grapes.

In the decade and a half since then, Adelsheim Vineyards has managed to overcome the injury caused by the incident – the company has expanded to 180 acres, and the five acres ravaged by the herbicide have largely recovered. Nonetheless, Adelsheim said the effects of the



MATEUSZ PERKOWSKI/For the Capital Press

David Adelsheim examines some grapes at his vineyards near Newberg, Ore. Fifteen years ago, herbicide drift damaged several acres of his grapevines, and Adelsheim said the affected plants have never fully recovered.



How might a GE crop be a co-existence issue for an organic farmer?

...What Genetic Modification Input Methods Are PERMITTED?

(§ 205.2 National Organic Program)

- they “...include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture.”



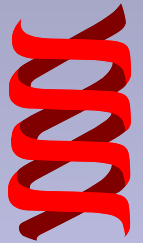
...And What Genetic Modification Input Methods Are PROHIBITED?

(§ 205.2 National Organic Program)

- “A variety of methods...are not considered compatible with organic production. Such

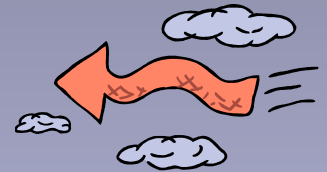
Are There Tolerances for GE in Organic Products?

positions of genes when achieved by recombinant DNA technology).”



There are tolerances for pesticides but not for GE content

☞ Pesticides: “When residue testing detects prohibited substances at levels that are greater than 5% of the EPA’s tolerance for the specific pesticide residue detected...the agricultural product must not be sold or labeled, or represented as organically produced.”



☞ GMOs: At the present time there are no specified tolerances for GMOs in organic products. Organic products are not ‘guaranteed’ GMO-free, although some organic farmers sign contracts guaranteeing GMO-free

What are some environmental issues?

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



- Planted soybeans in field previously used for transgenic corn.
- USDA APHIS discovered "volunteer" corn plants growing among soybeans; ProdiGene instructed to remove corn.
- Soybeans harvested before corn was removed, became mixed with 500,000 bushels of soybeans.

Production of pharmaceuticals in edible crops caused concern because of transgenic corn contaminating subsequent soy crop – resulting in fines over \$1M

In part because of examples like Prodigene, USDA tightened rules on Pharm/Industrial Crops

- **Crop inspection 7 times; 5 in growing season, 2 after harvest**
- **Field isolation distances increased**
- **Dedicated farm equipment required**
- **Permits required for industrial crops, like pharm crops**

'Pharm crop' debate takes root in California Biotech

By Paul Jacobs and Lisa M. Krieger
Mercury News

YUBA CITY - An experimental new form of rice, engineered to produce commercial

California company growing pharma rice with two genes to speed recovery from childhood diarrhea moved field production to Kansas away from rice-growing area.

If it gets the necessary approvals, the decade-old company would become the first commercial producer of genetically engineered ``pharm crops." Scientists

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 growing genetically engineered corn producing industrial and pharmaceutical proteins in fields... found to violate government regulations with minimal to no retribution. Company president involved in earlier similar violations with another company called Prodigene."

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>



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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.

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

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For grades 5-8, covers topics from plant diversity to genetic engineering. Each of the five lessons has 3 to 5 activities.

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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.

 **Who's In YOUR family?**

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.



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Go to Issues and Responses section on drop-down menu from Biotechnology Information section. Chose a category to see what issues are there or type your question in “search by phrase”. Hit search.

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Common issues and responses, related to topics like agriculture, foods, food safety, bioenergy, agricultural practices and biotechnology, are covered and include scientific references. Content and choice of literature is the sole responsibility of Dr. Peggy G. Lemaux. Some issues are updated from two Annual Review of Plant Biology articles [Part I](#) | [Part II](#). Note our policy regarding [outside links](#).

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