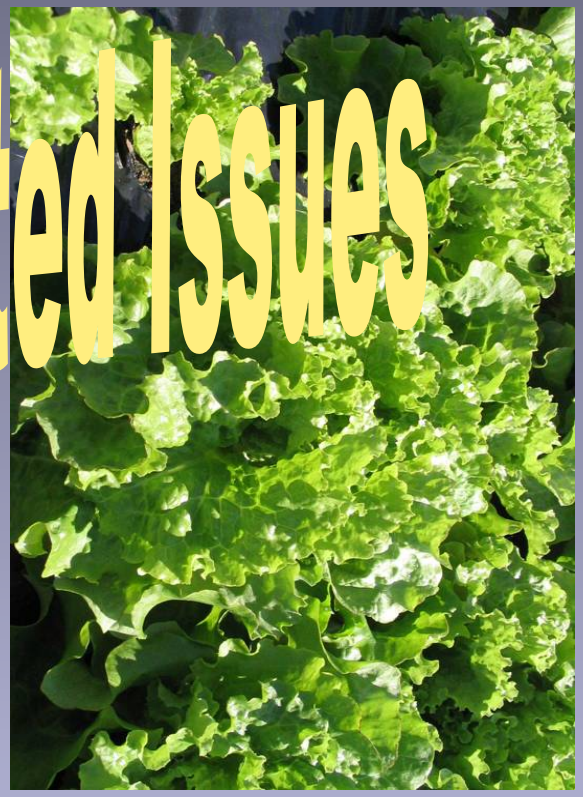
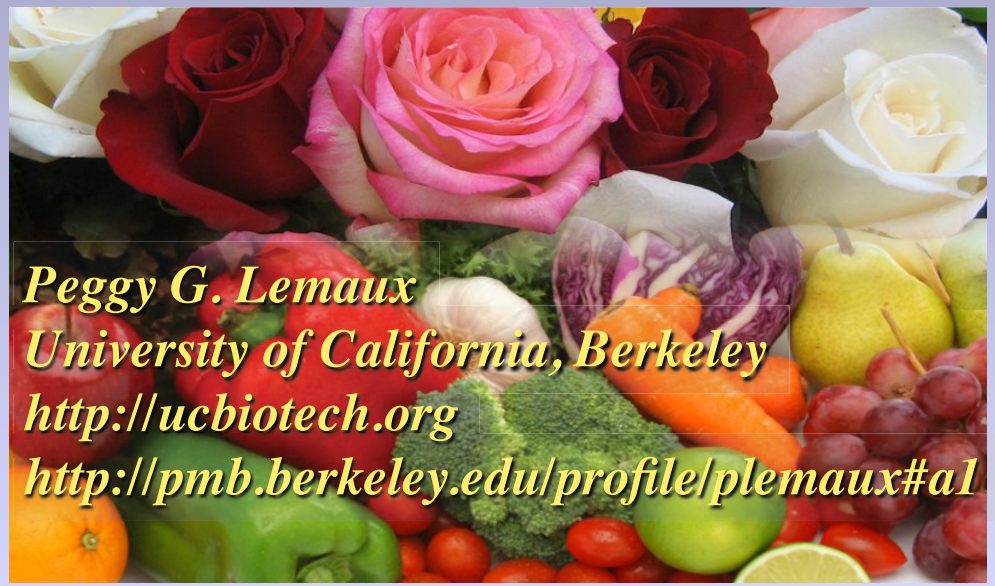
The Science of GMOs and Related Issues





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

ucbiotech.org

What will be covered?

1. Background on genes, genetics, genetic engineering
2. What GE crops are commercialized? In the pipeline?
3. What is the regulatory structure for GE crops?
4. What are food safety issues with GE foods?
5. What are environmental issues with GE crops?

Tour d'Onion

Or what makes an onion, an onion?

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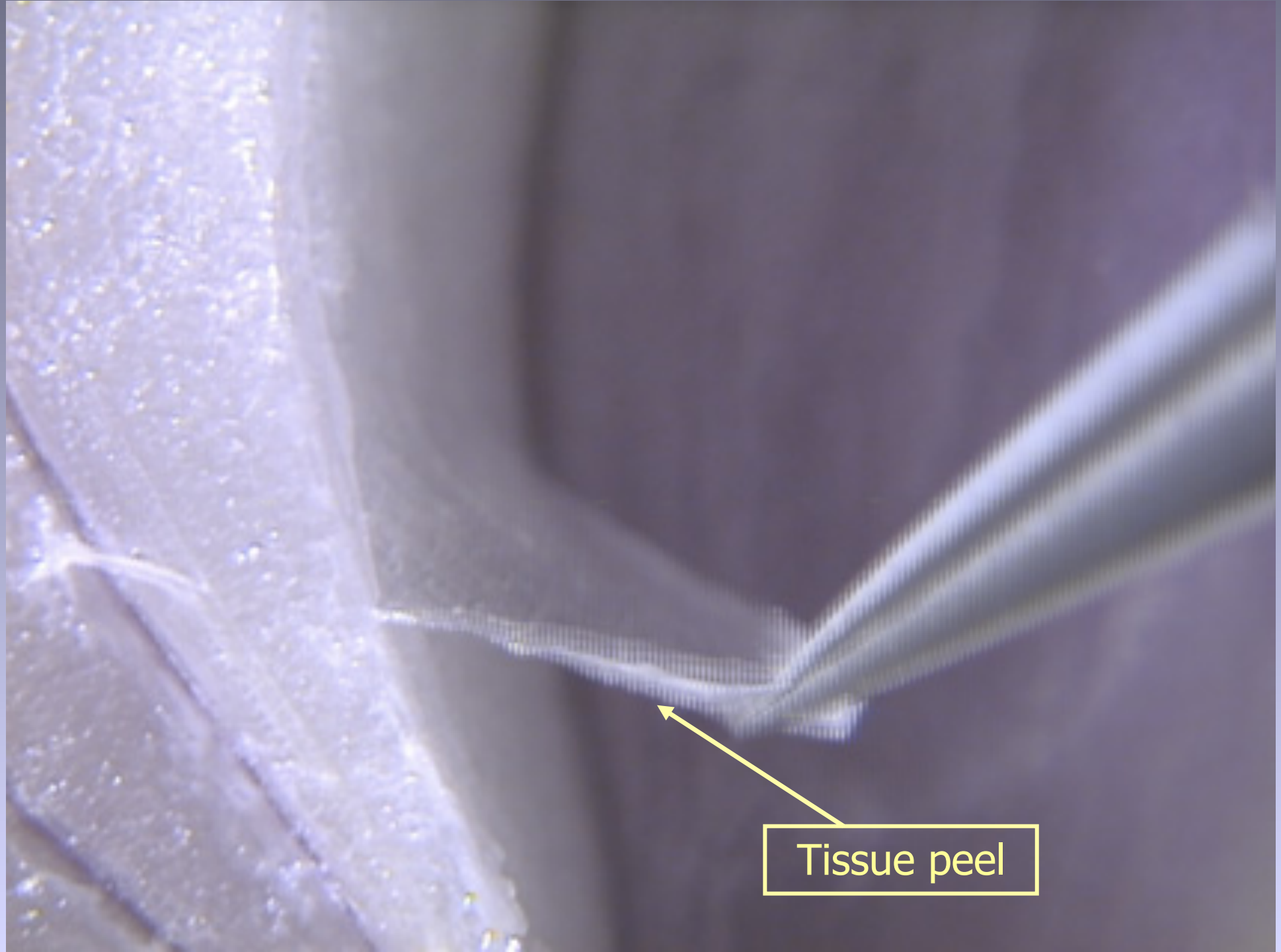
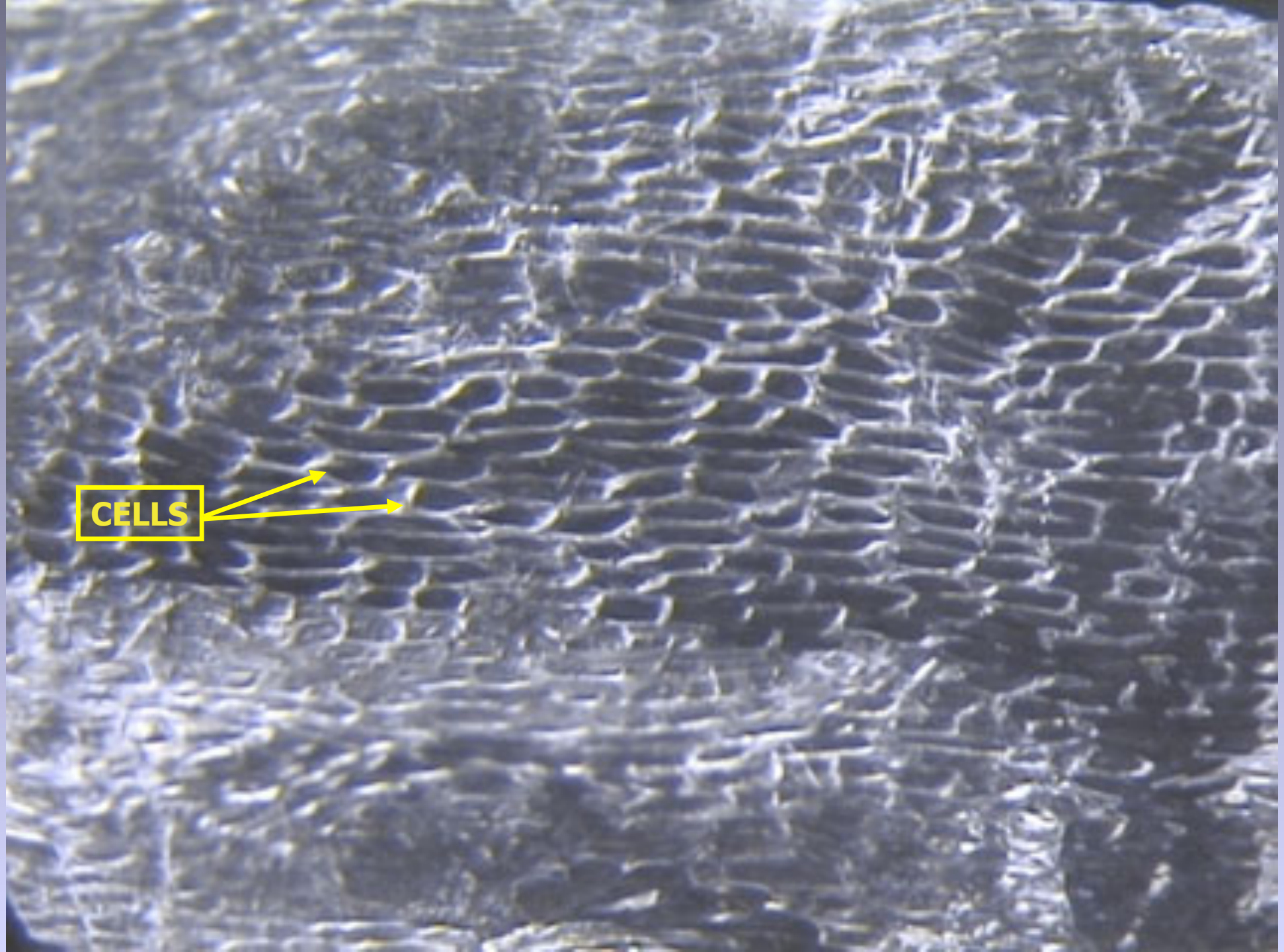
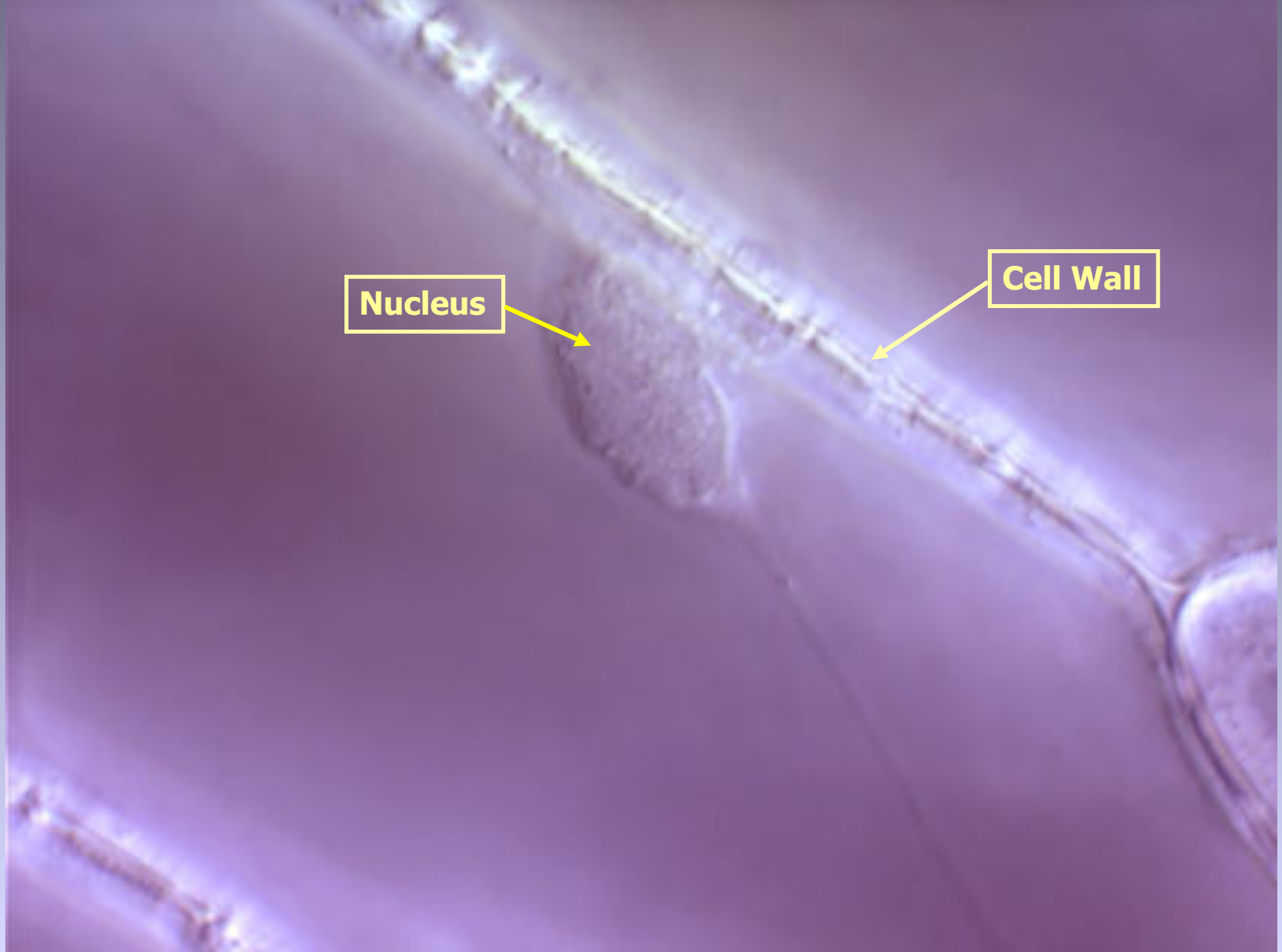
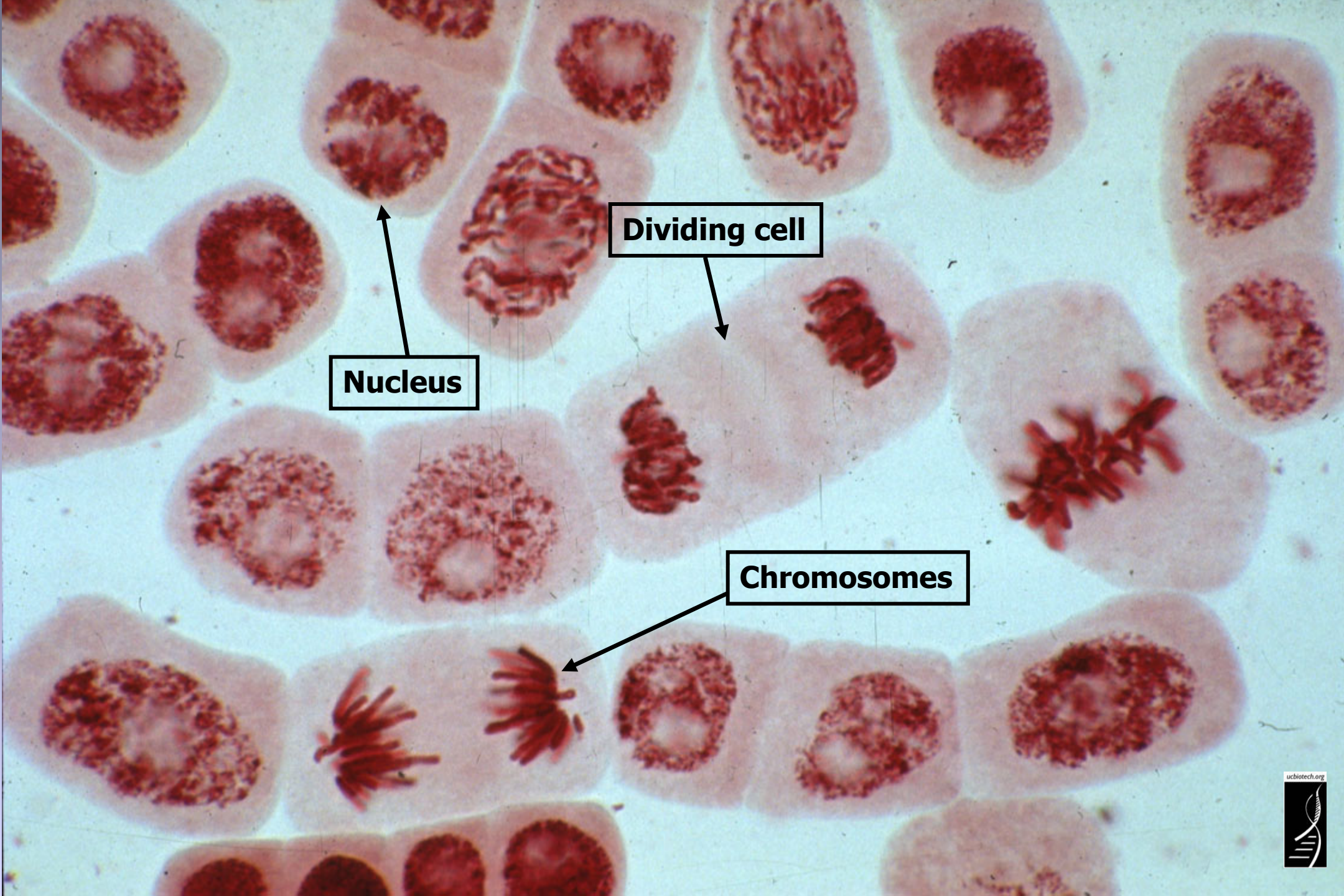
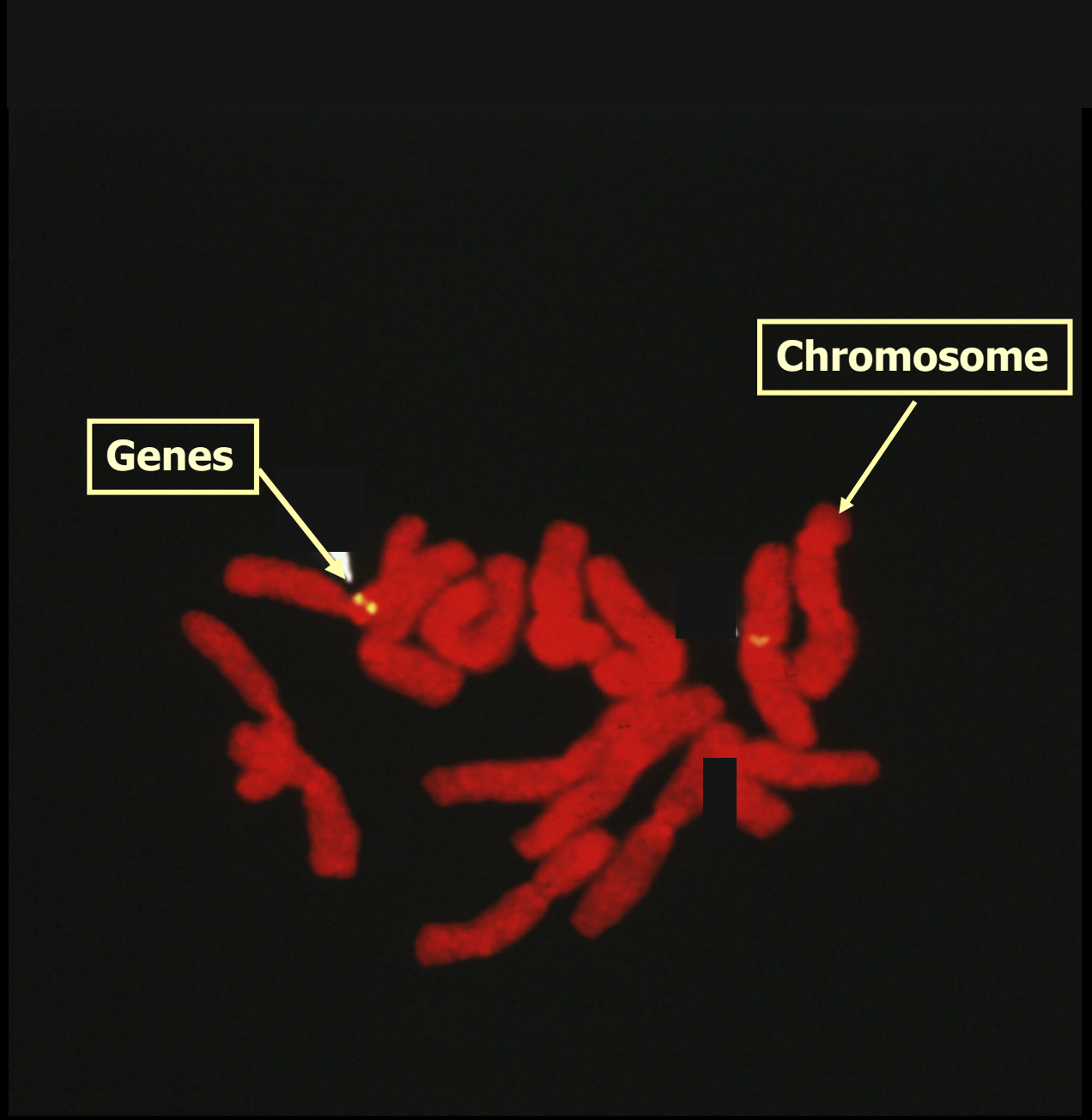

Tissue peel


CELLS


Nucleus
Cell Wall


Dividing cell
Nucleus
Chromosomes


Chromosome
Genes

How are the genes and chromosomes manipulated to create a new plant variety by classical breeding?

Triticum monococcum

Ancient variety

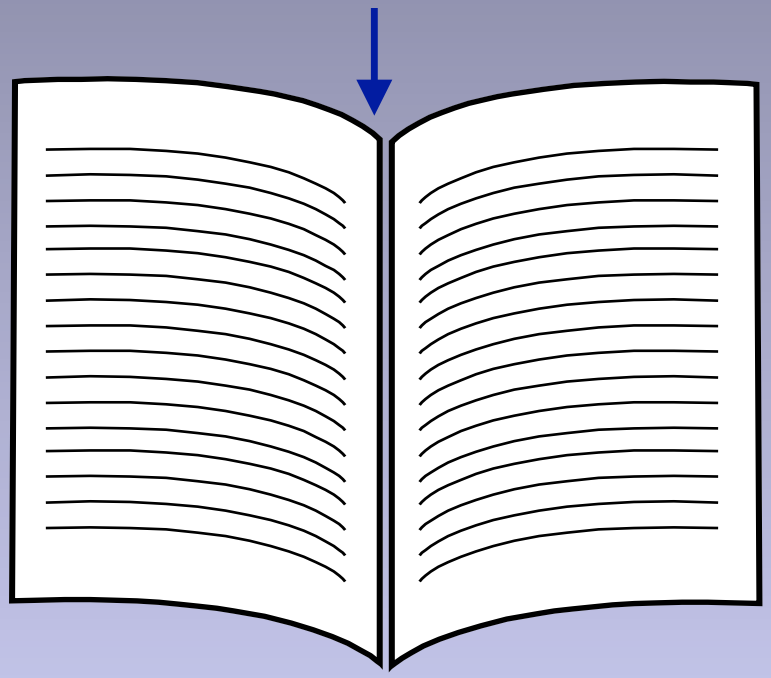
Triticum aestivum

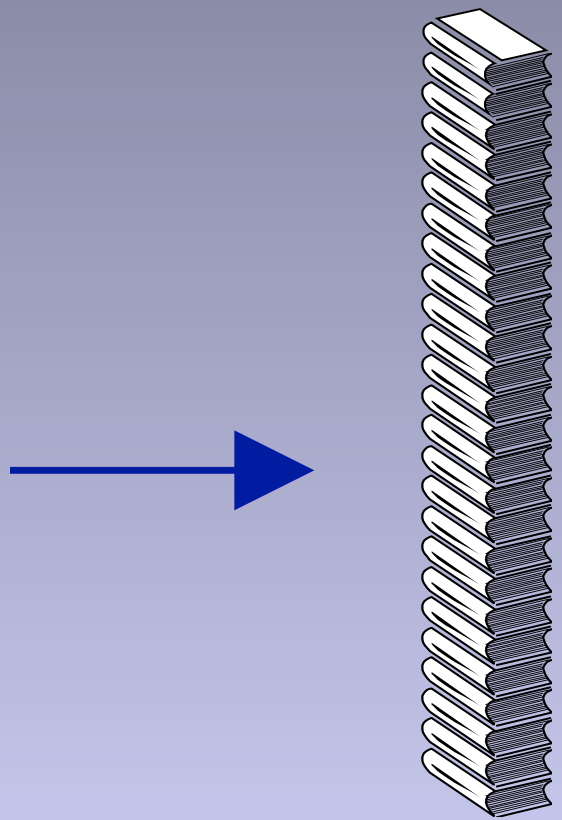
Modern bread variety

Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...

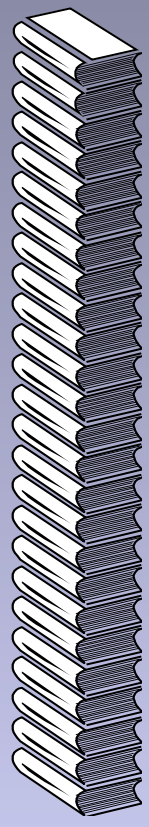




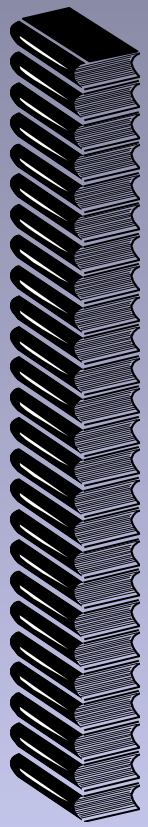
1700 books
1000 pages each

1700 books
(or 1.7 million pages)

Hybridization or cross breeding of wheat



X

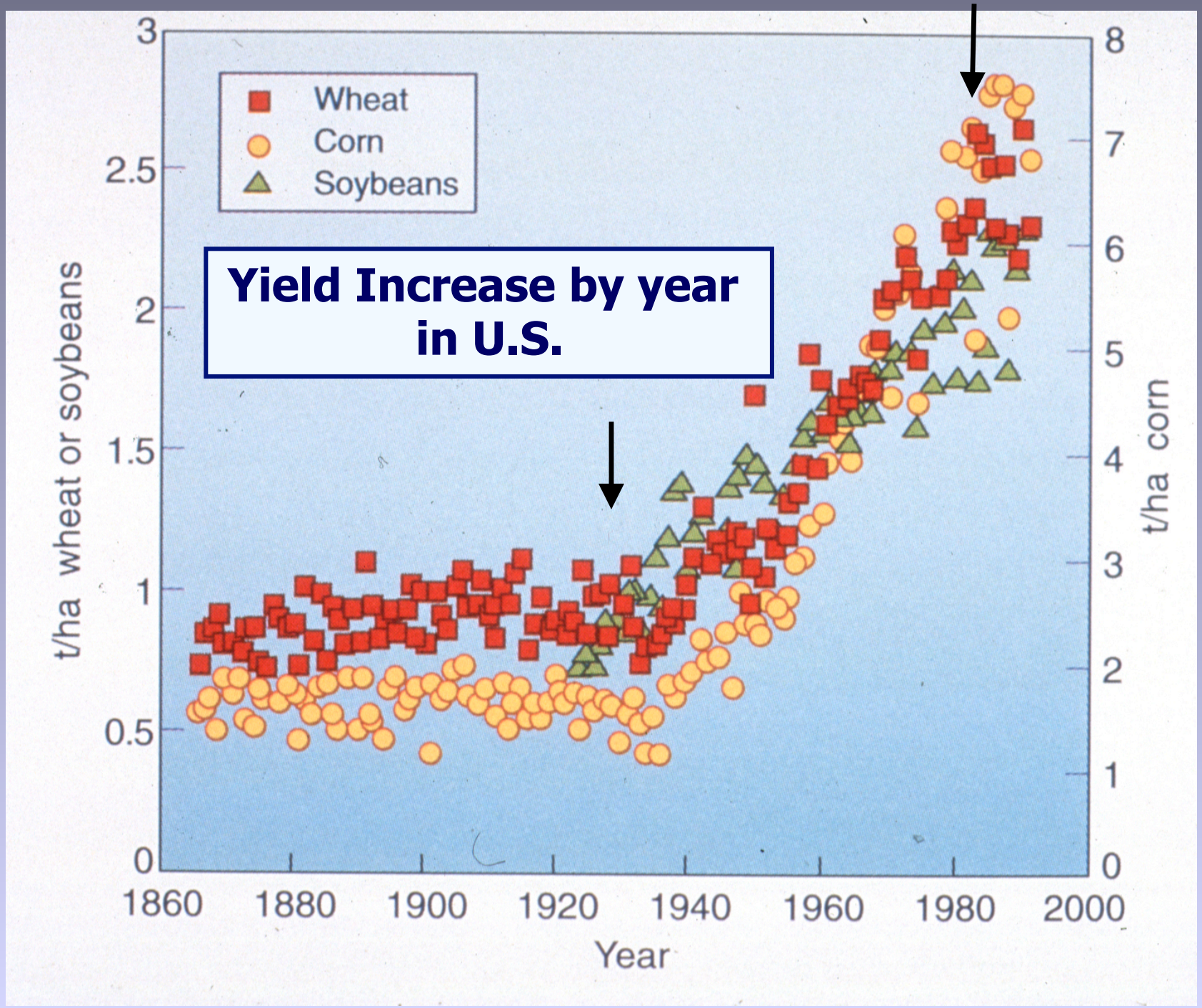


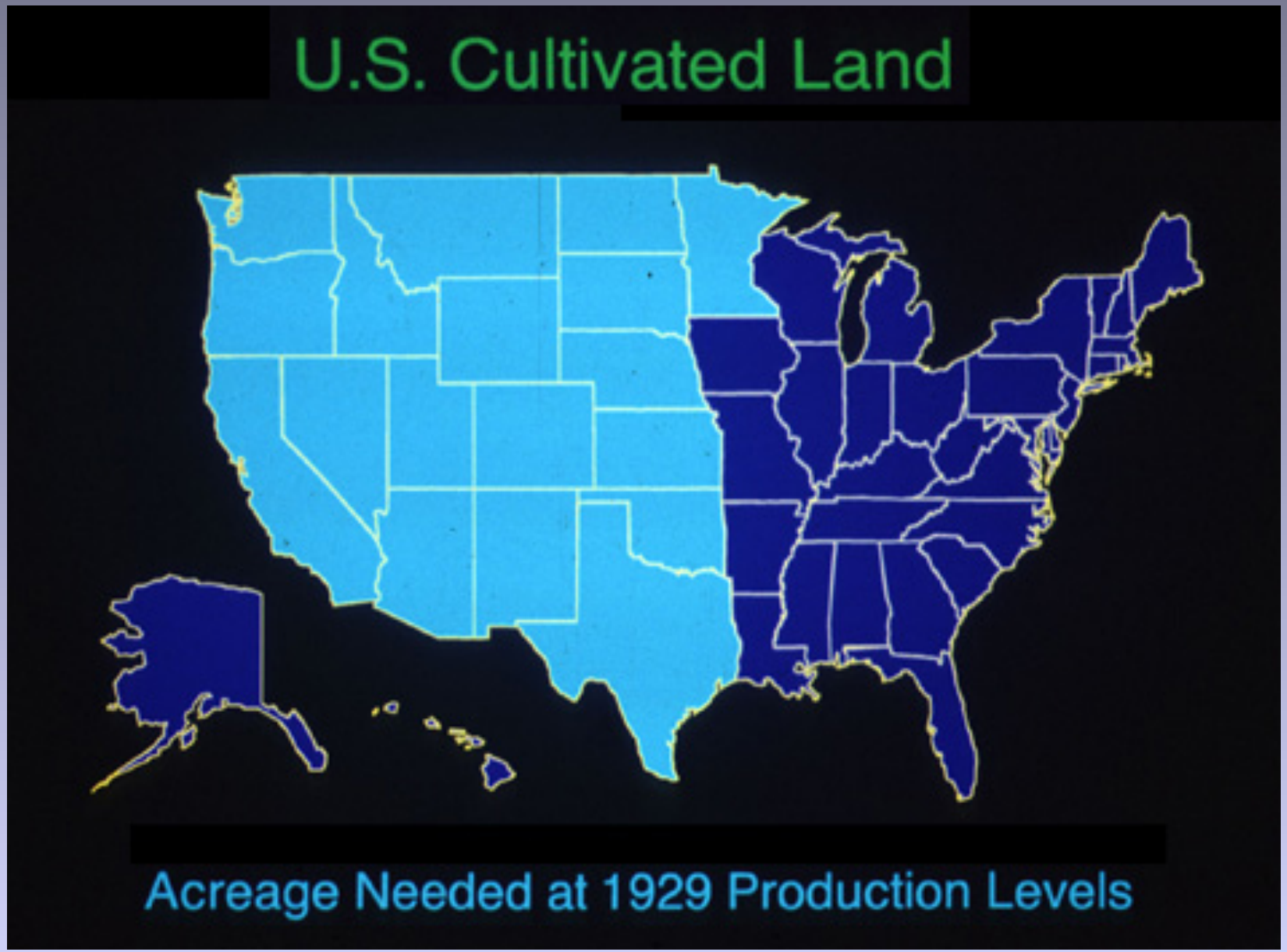
Random retention of information from each parent

1700 books
(or 1.7 million pages)

1700 books
(or 1.7 million pages)

1700 books
(or 1.7 million pages)


Wheat
Corn
Soybeans
Yield Increase by year in U.S.
t/ha wheat or soybeans
t/ha corn
Year
0
0.5
1
1.5
2
2.5
3
0
1
2
3
4
5
6
7
8
1860
1880
1900
1920
1940
1960
1980
2000



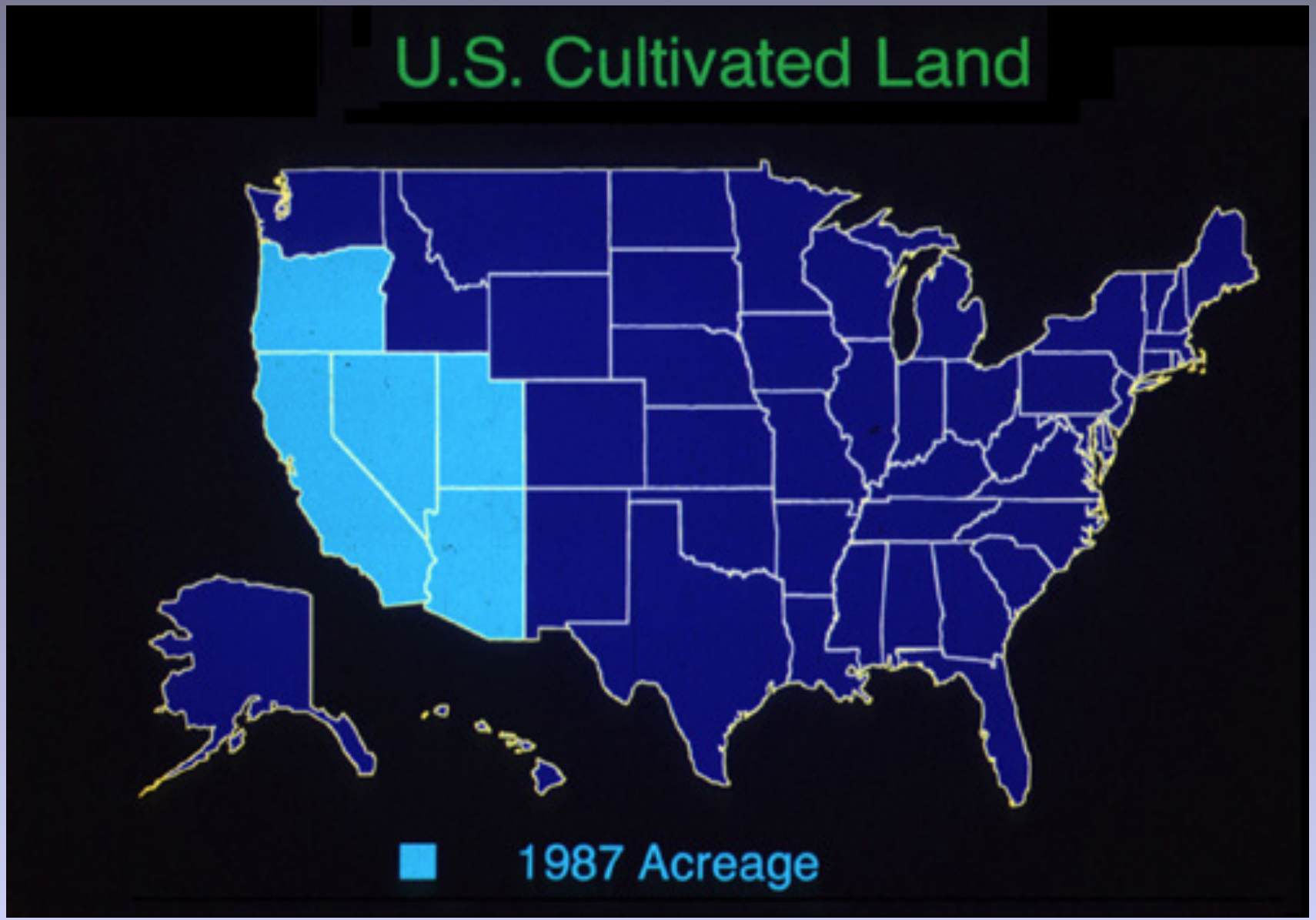
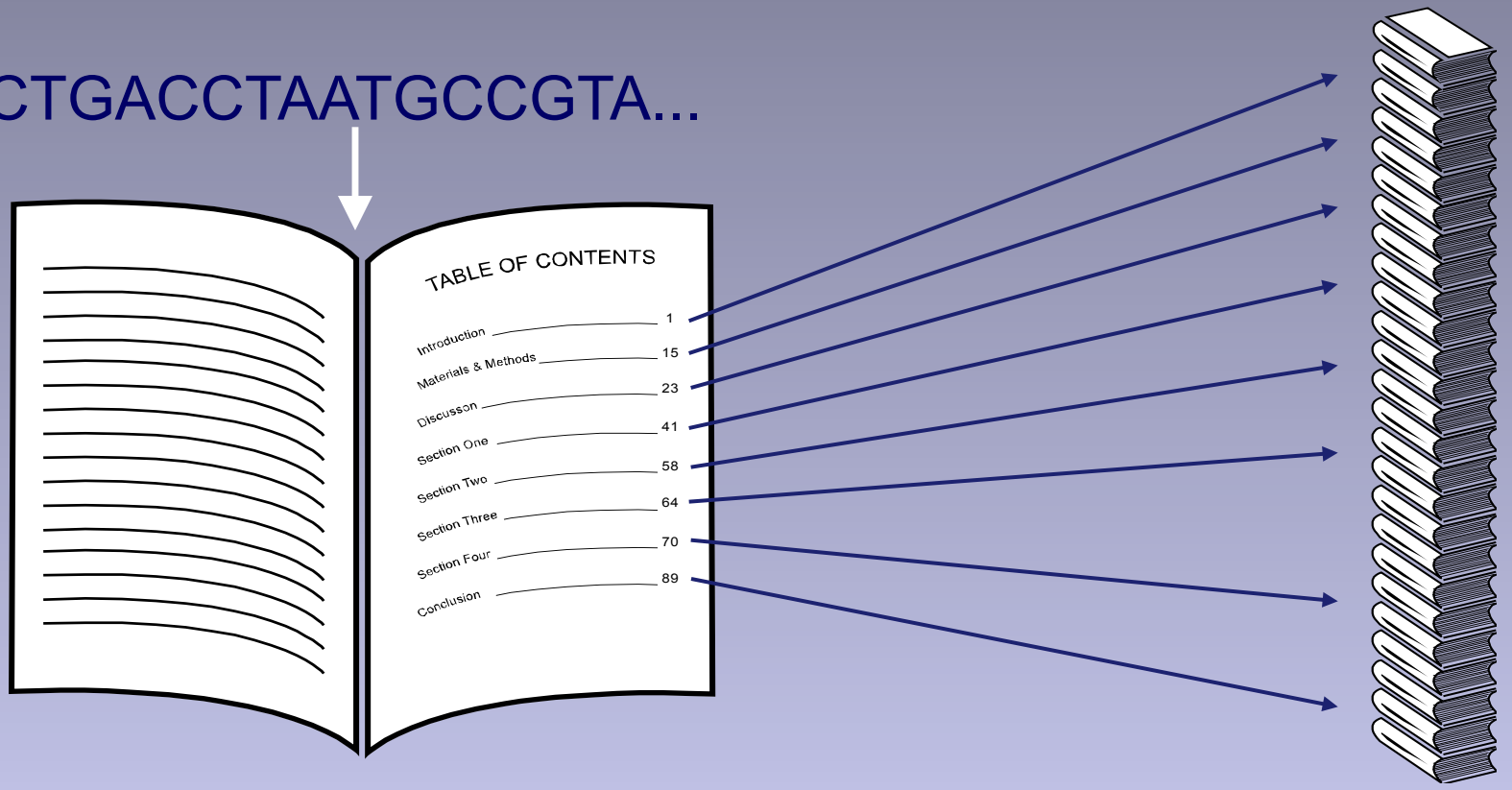


Table of contents for genes in wheat

...CTGACCTAATGCCGTA...



Genomics

Used for Marker-Assisted Selection

1700 books (or 1.7 million pages)

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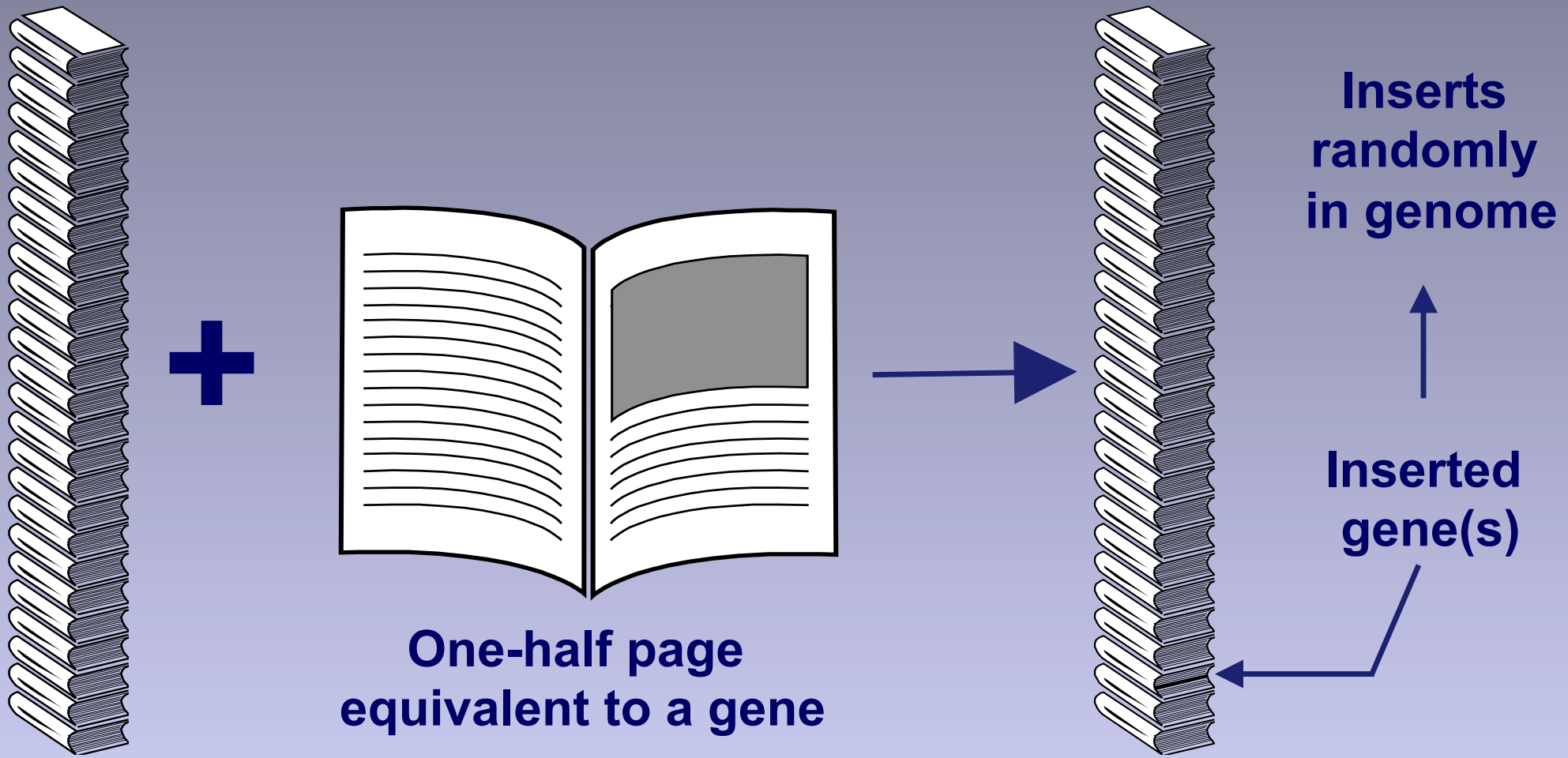
Marker-assisted selection used to protect rice against bacterial blight and blast disease

Protection limited to diversity in crop and compatible relatives


But there are other ways to create new varieties using the modern tools of genetics
ucbiotech.org

Genetic Engineering Methods



Classical Breeding compared to *Genetic Engineering*

Classical Breeding	*Genetic Engineering*
Uses plant machinery in plant	Uses plant machinery in laboratory
Gene exchange is random involving whole genome	Gene exchange is specific involving single or few genes
When/where gene expressed not controlled by breeder	When/where gene expressed controlled precisely
Source of gene primarily within genera – not between kingdoms like plants & bacteria	Source of gene from any organism


How do you engineer a crop, citrus, for example?
SOURCE: "A Race to Save the Orange by Altering Its DNA", New York Times, July 27,
http://www.nytimes.com/2013/07/
ce/a-race-to-save-the-orange-by-altering-its-dna.html?pagewanted=
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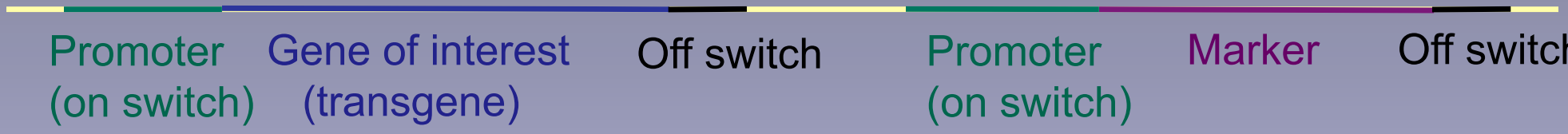
What Is Engineered into the Plant? Construct with Gene of Interest Created Using Recombinant DNA?



Promoter: controls when and where gene is made

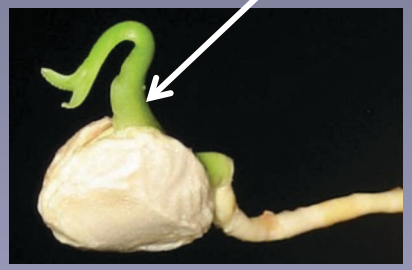
Off switch: stops expression of gene

Gene of interest: gene you want to introduce into plant

Marker: used to identify which cells have gene of interest

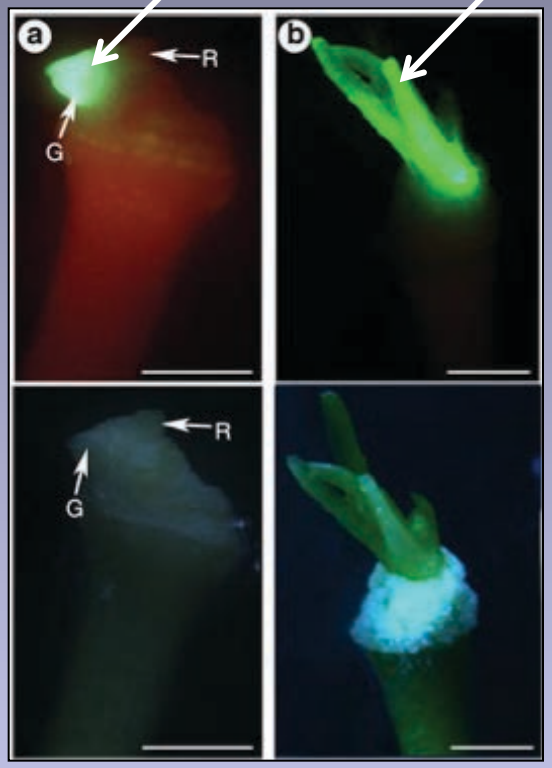
Plant Transformation of Citrus

Excision of tissue on germinating shoot



Infecting plant cell with naturally occurring bacterium containing gene of interest

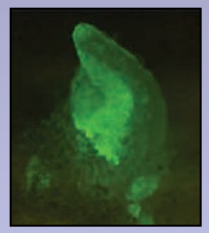
Group of cells making product from gene of interest – green fluorescent protein



Development of engineered shoots from single original cell receiving gene of interest

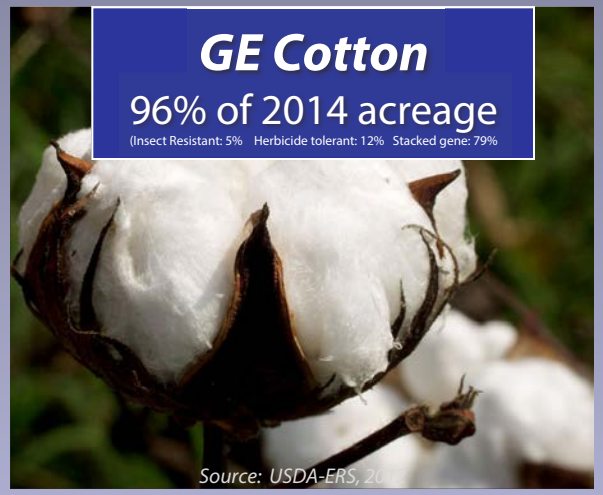
Regenerating plantlet with gene of interest

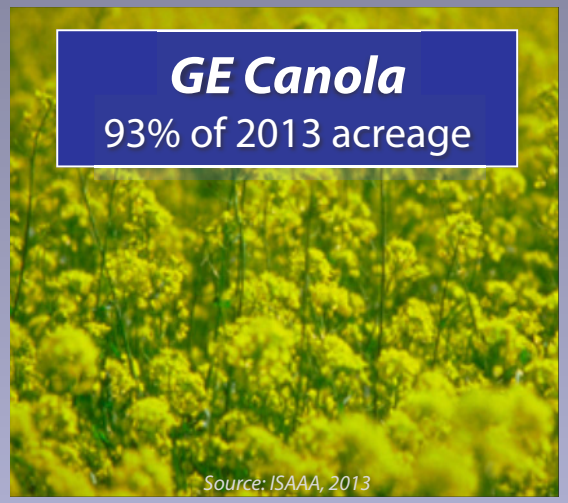
Regenerated rooted plant making introduced product

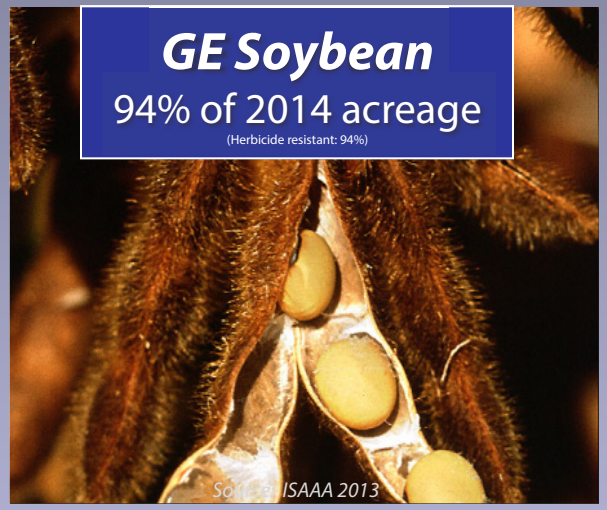


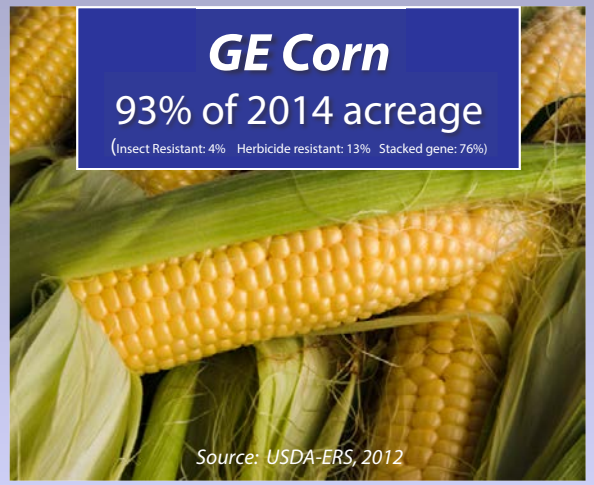
Confirmation of gene of interest

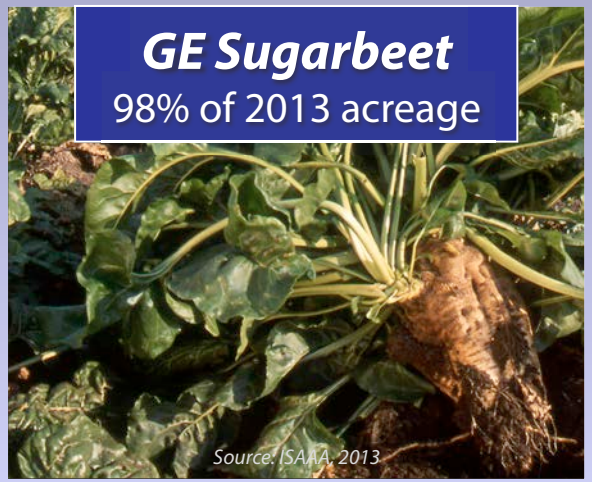
Number of different commercially available large acreage GE crops is limited

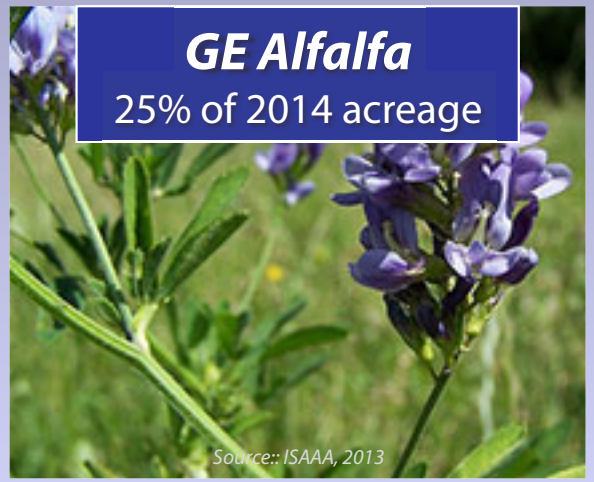












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Number of different traits available in GE crops is also limited

Bt Crops - engineered for insect resistance using gene from naturally occurring bacterium

Herbicide-tolerant - engineered with genes to tolerate herbicide application

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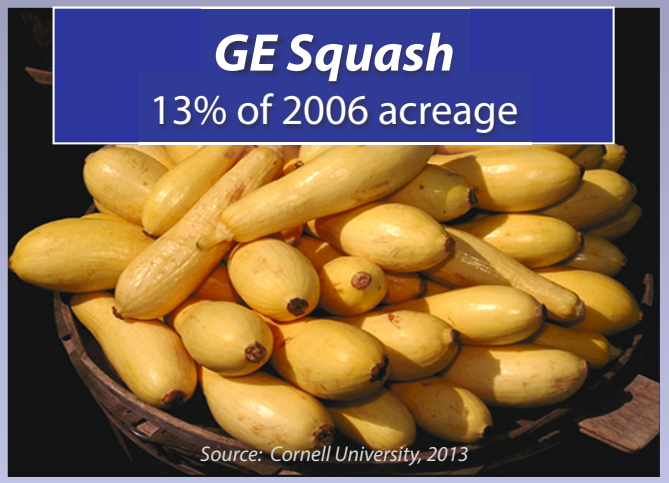
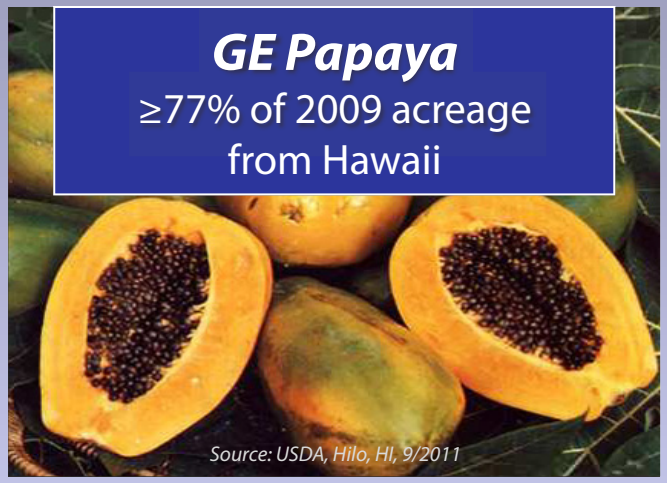
These types of large-acreage GE crops lead to estimates that 60-80% of processed foods in U.S. have GE ingredients

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

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





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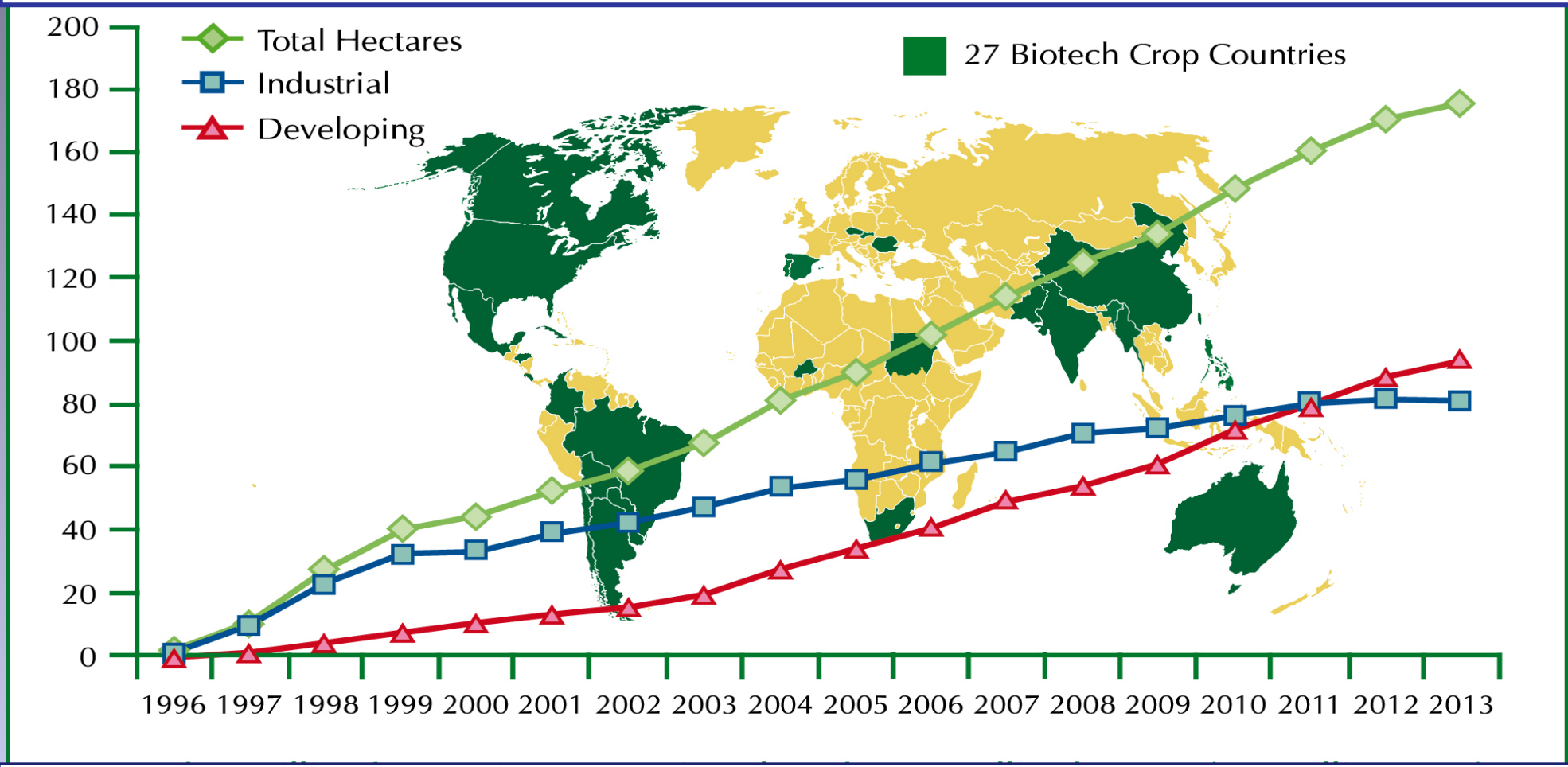
Despite the same limited U.S. crop and trait types, worldwide acreage is increasing in 20 developing, 8 developed countries



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

WHAT'S IN THE PIPELINE?

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Field Trials Conducted in California with Grape Root Stocks Engineered for Resistance to Fanleaf Virus

SOURCE: http://www.democratandchronicle.com/apps/pbcs.dll/article?AID=/20080806/BUSINESS/808060336/1001

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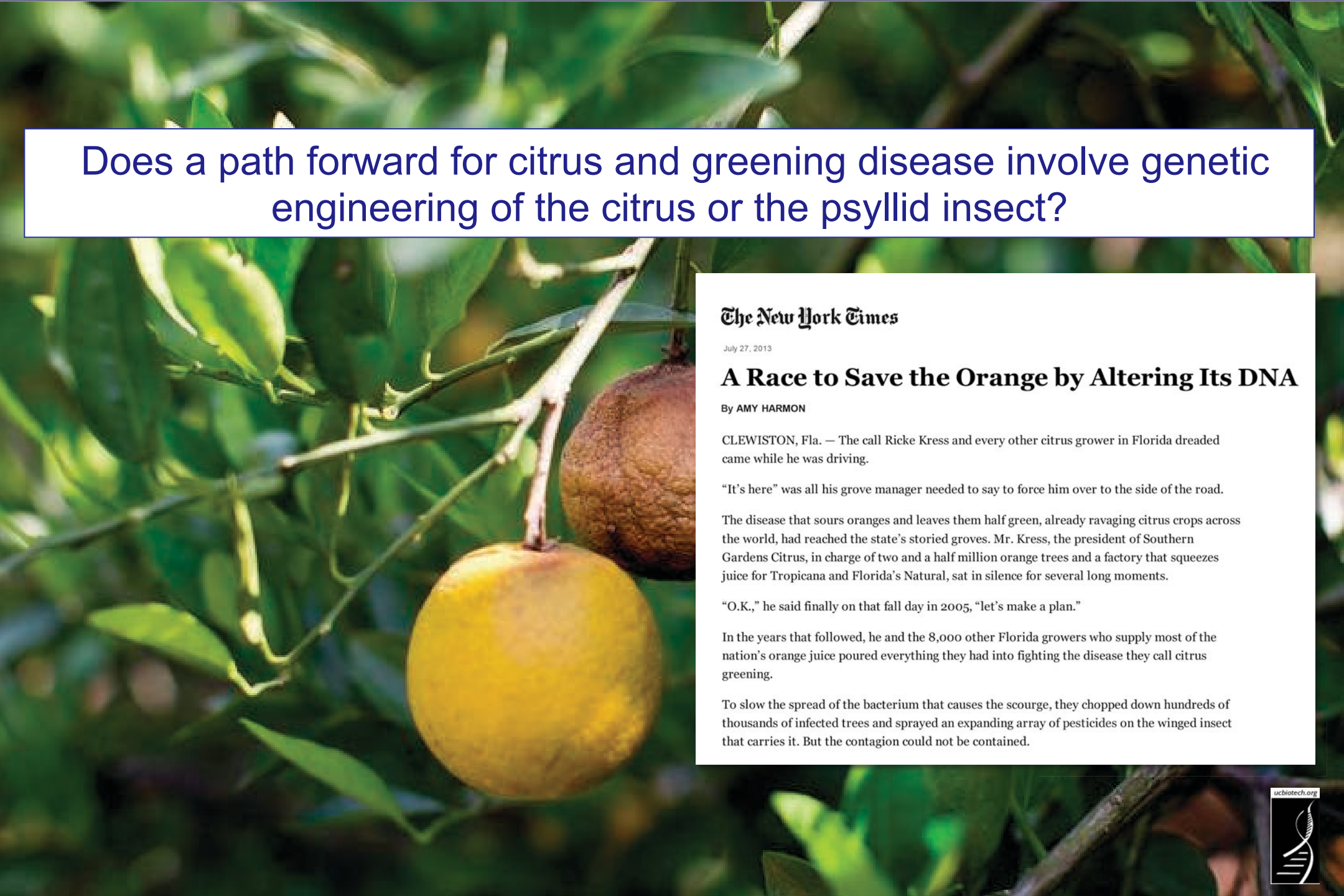
Does a path forward for citrus and greening disease involve genetic engineering of the citrus or the psyllid insect?



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.

"It's here" was all his grove manager needed to say to force him over to the side of the road.

The disease that sours oranges and leaves them half green, already ravaging citrus crops across the world, had reached the state's storied groves. Mr. Kress, the president of Southern Gardens Citrus, in charge of two and a half million orange trees and a factory that squeezes juice for Tropicana and Florida's Natural, sat in silence for several long moments.

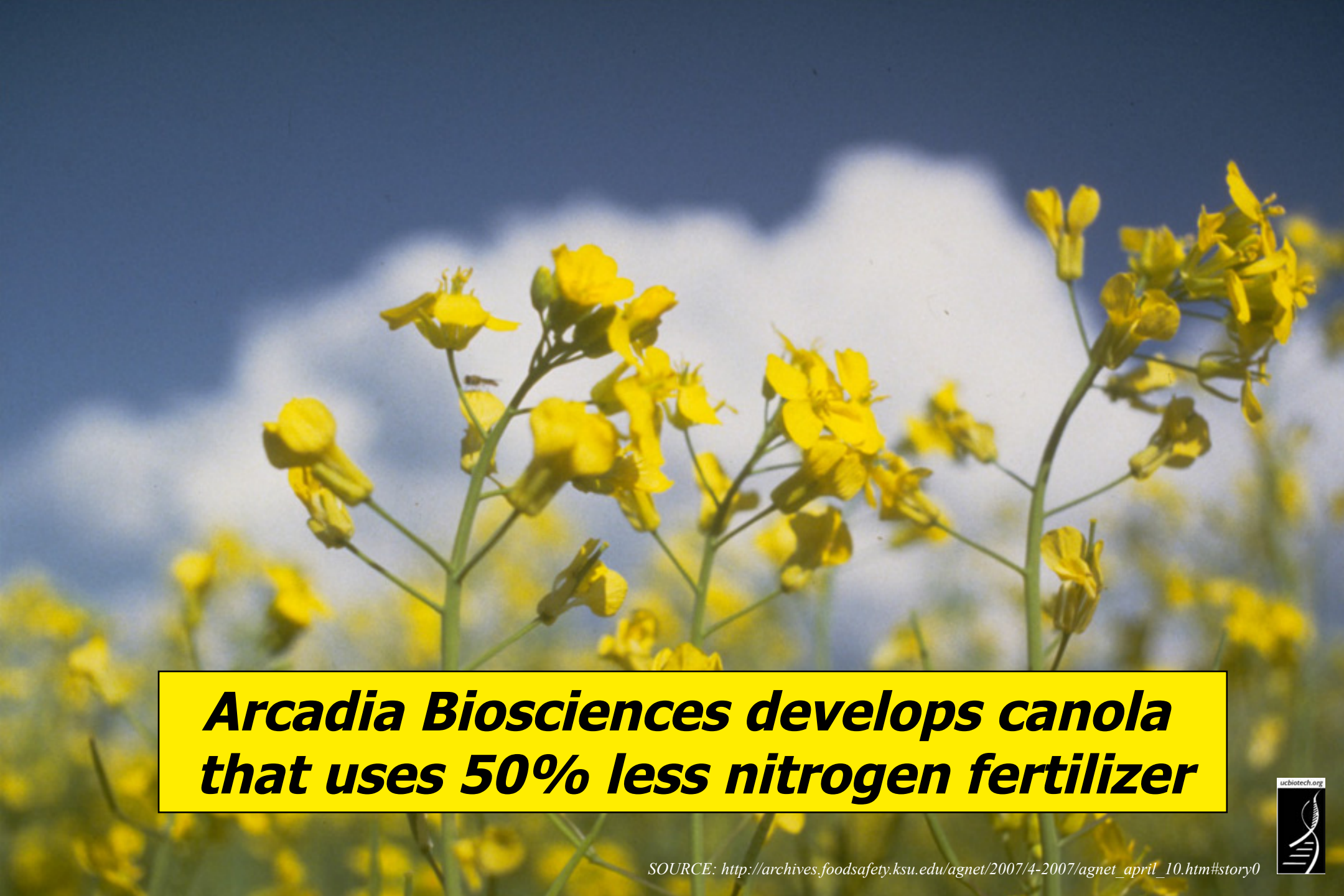
"O.K.," he said finally on that fall day in 2005, "let's make a plan."

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.

Australian researchers identify grape genes that provide resistance to powdery mildew

SOURCE: Western Farm Press, volume 26, number 16



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

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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.

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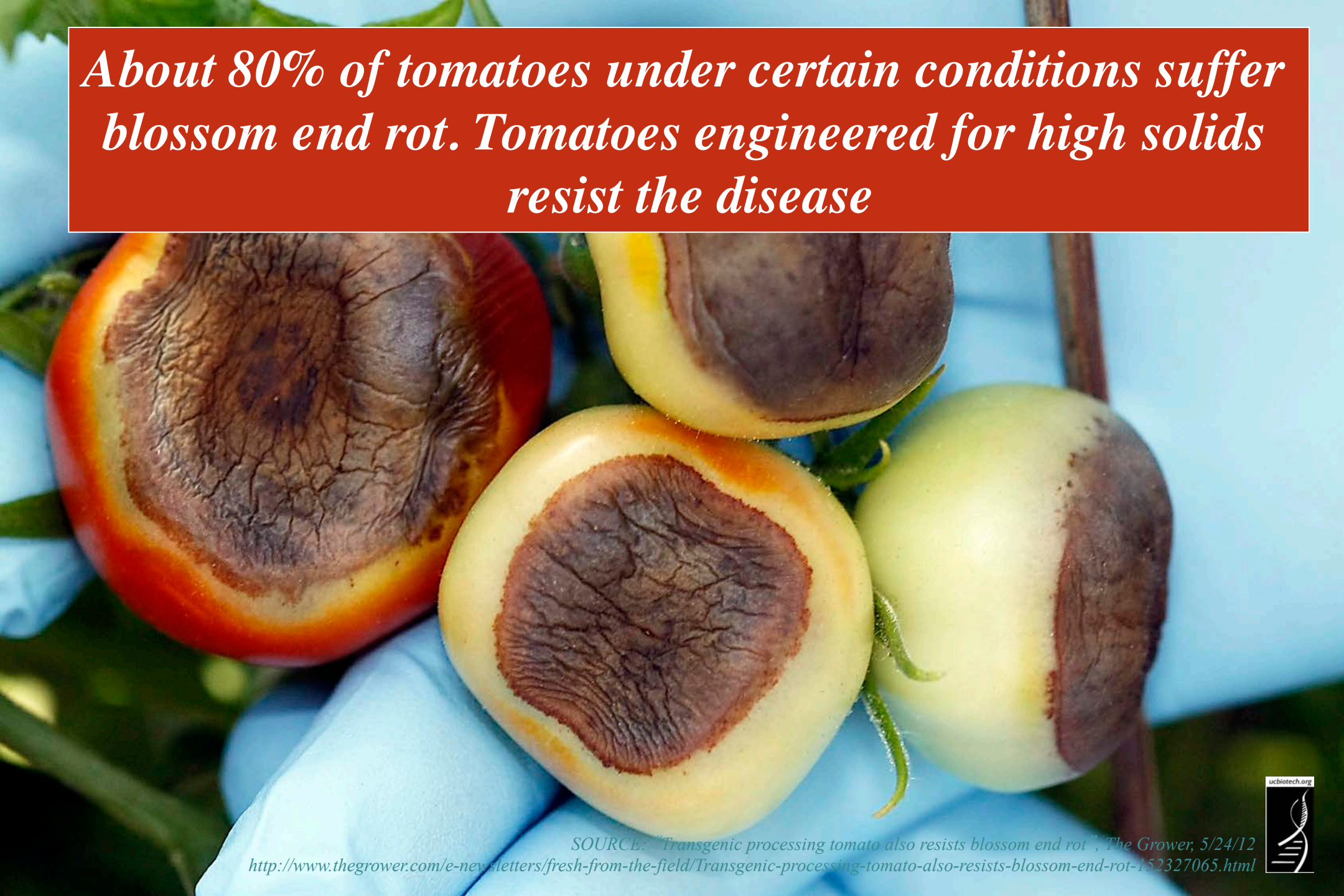
About 80% of tomatoes under certain conditions suffer blossom end rot. Tomatoes engineered for high solids resist the disease



SOURCE: "Transgenic processing tomato also resists blossom end rot", The Grower, 5/24/12
http://www.thegrower.com/e-newsletters/fresh-from-the-field/Transgenic-processing-tomato-also-resists-blossom-end-rot-152327065.html

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High anthocyanin purple GE tomatoes protect against cardiovascular disease and certain cancers. Diets with 10% purple tomatoes increased lifespan of cancer-prone mice

Golden Rice engineered to contain bioavailable pro-Vitamin A

Normal portion of Golden Rice 2 provides half of a child's Vitamin A needs

Innate™ (L) and traditional (R) potato
10 hours after cutting

Low acrylamide, low sugar, bruising-resistant potato engineered only with potato DNA – under consideration for deregulation by APHIS

Canadian Okanagen Specialty Fruits will voluntarily label their nonbrowning GE apples

SOURCE: "This GMO Apple Won't Brown. Will That Sour The Fruit's Image?", Wisconsin Public Radio News, January 8, 2014.
http://news.wpr.org/post/gmo-apple-wont-brown-will-sour-fruits-image
Photo courtesy of Okanagan Specialty Fruits Inc.

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Engineered Peas 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
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.

Japanese scientists create blue rose with blue pigments from pansies

SOURCE: http://www.japantimes.co.jp/cgi-bin/getarticle.pl5?nn20040701a2.htm

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

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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 – 111 granted

(8-2-2014)

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
- ❖ Plum - VR
- ❖ Rice - HT
- Rapeseed - HT, AP, PQ
- ✓ Sugar beet – HT - removed, reinstated
- ❖ Flax - HT
- ❖ Chicory - AP
- ❖ Tobacco – PQ
- ❖ Rose - PQ

✓Large-scale production
❖Not on market

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

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

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It started in Europe: Factors that fueled and continue to fuel the controversy in Europe

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

Then: Lord Melchett participating in GM protest – 1999

Controversy Continues today in Europe (Germany) February 2014

GMO HATE. People protests against the authorization of genetically modified (GM) maize with signs and banners reading 'Stop GMO Maize 1507 ', 'Only a NO can protect us' and 'No to GMO Maize 1507' in front of the Federal Chancellor's Office in Berlin, Germany, 05 February 2014. Joerg Carstensen/EPA

Genetically modified potatoes are studied, criticized in Ireland

In a secured government greenhouse in Carlow, Ireland, plant scientist Ewen Mullins examines transplants of genetically modified potatoes engineered to resist late blight disease. (Adrian Higgins/The Washington Post)

Even with a product that addresses an E.U. issue that led to thousands of deaths in the very country that helped develop a "cure" for late blight - responsible for the Irish potato famine

Evangelical megachurch begins closing

THE WASHINGTON POST

Obama announces 'broad coalition' to fight

THE DENVER POST

Von Miller's sluggish Game 1 fuels fire

Most popular stories from around the web THE MOST >

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But anti-GE sentiment is not universal. German farmers protest field destruction, demanding punishment for people committing these acts

What Are Some Other Issues?

What are some food safety issues?

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

What are some environmental and other issues?

- Transfer of engineered genes to non-GMO/ organic crops?
- Development of herbicide-tolerant weeds or pesticide-resistant insects
- Spread of pharmaceutical genes into commercial crops?
- Loss of genetic diversity?
- Property rights (gene patents)?

What are some food safety issues?

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

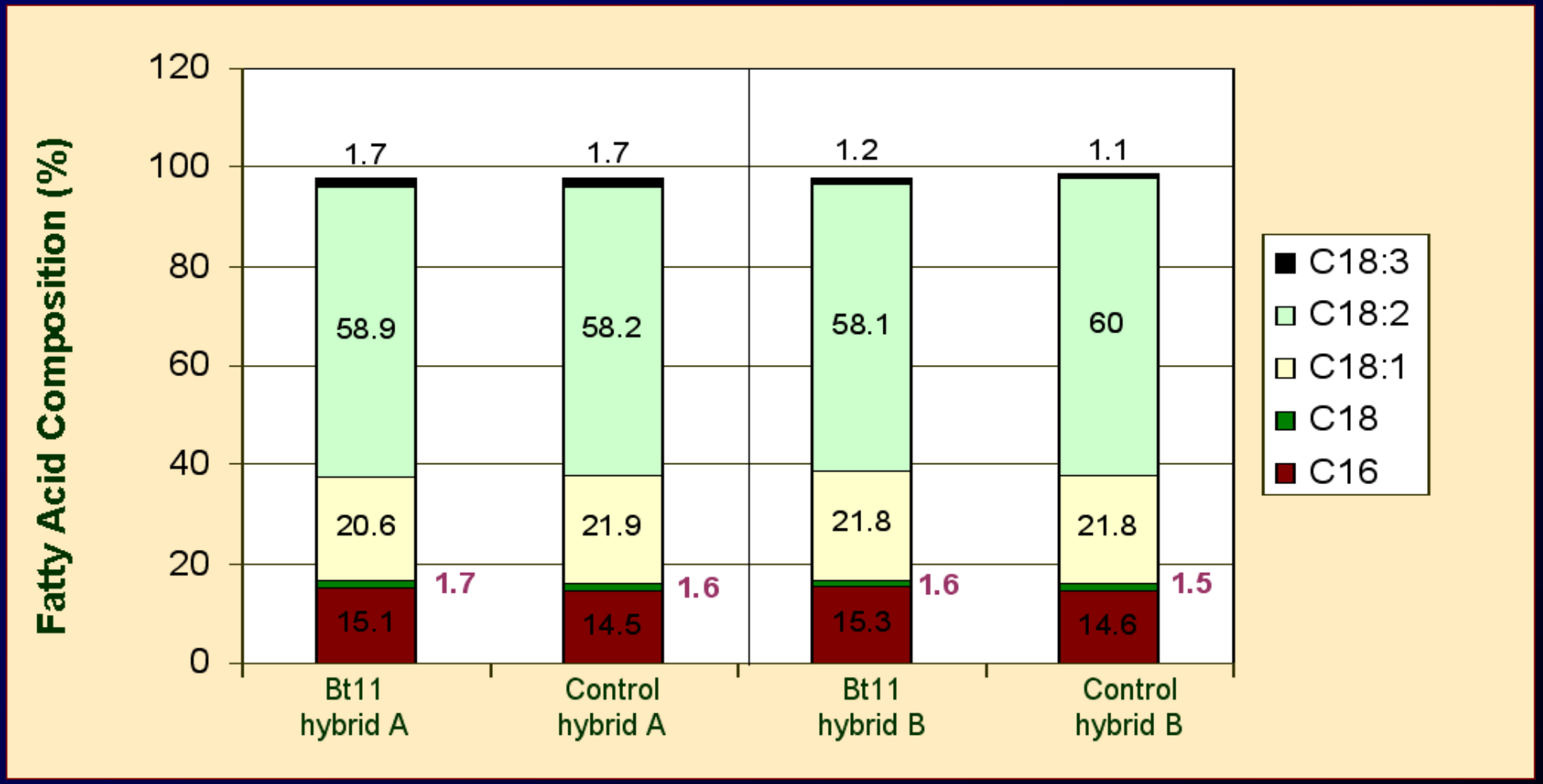
FDA uses the concept of **substantial equivalence:**

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

For introduced genetic material and 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

SOURCE: Safety of Genetically Engineered Foods: Aproaches to Assessing Unintended Health Effects 2004. Natl Acad Press

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.

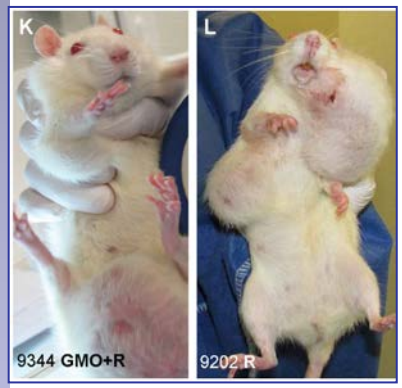
Intermittent studies are published casting doubts on GE food safety, like this one published by a French researcher in Sept. 2012 –

Subsequently reviewed by European Food Safety Authority and found to have no merit but did consumers "hear this?

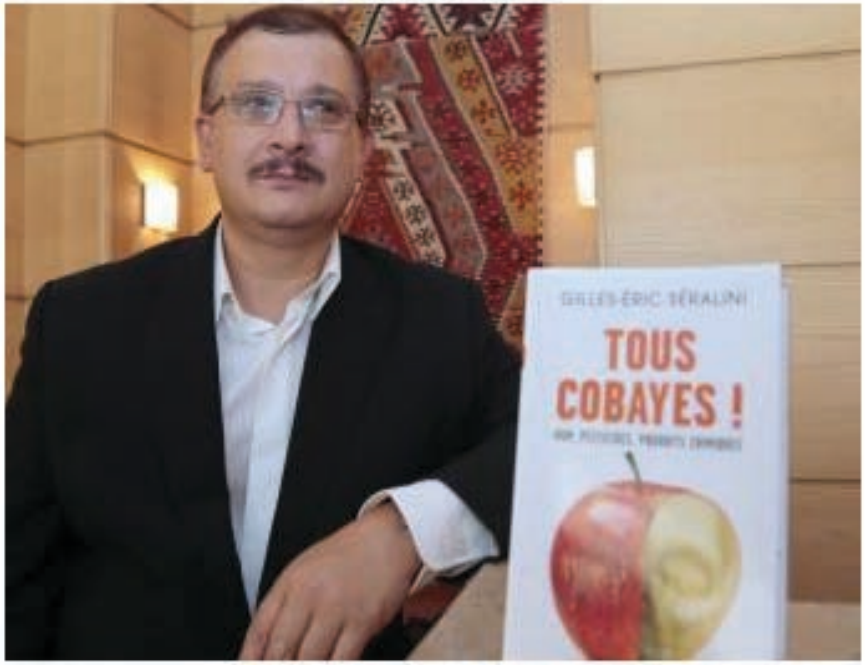
French academies trash GM corn cancer study

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 Séralini, with his book All Guineapigs
AFP /Jacques Demarthon

It's studies like these that trigger consumers' food safety fears… featured on Dr. Oz show

2012 Meta-analysis from France Shows GM foods are Safe

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

Did Consumers "hear" about this?

SOURCE: Snell C, Bernheim A, Berge J-P, Kuntz M, Pascal G, Paris A, Ricroch AE. 2012. Assessment of the health impact of GM plant diets in long-term and multigenerational animal feeding trials: A literature review. Food and Chemical Toxicology 50: 1134-1148.

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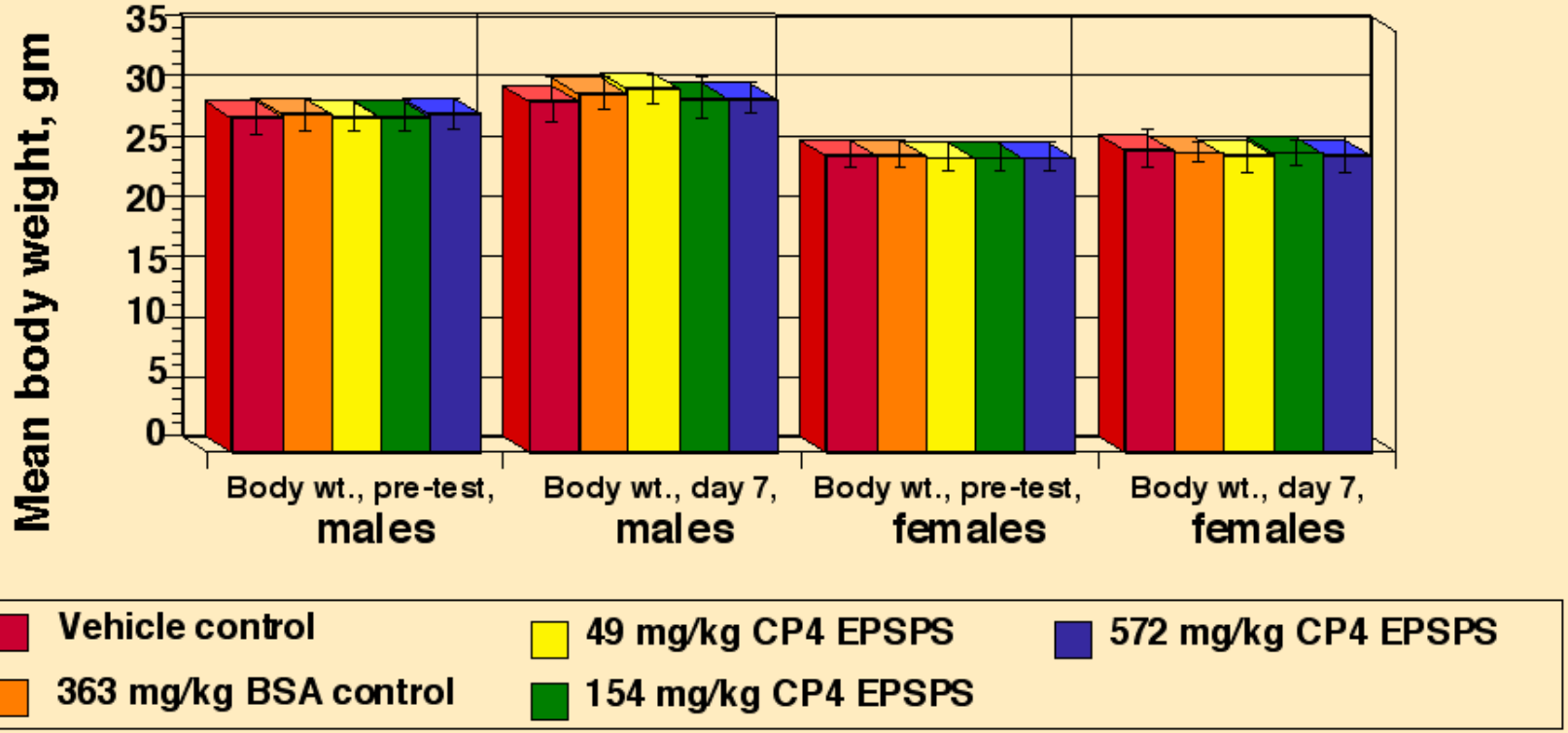
What are some food safety issues?

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

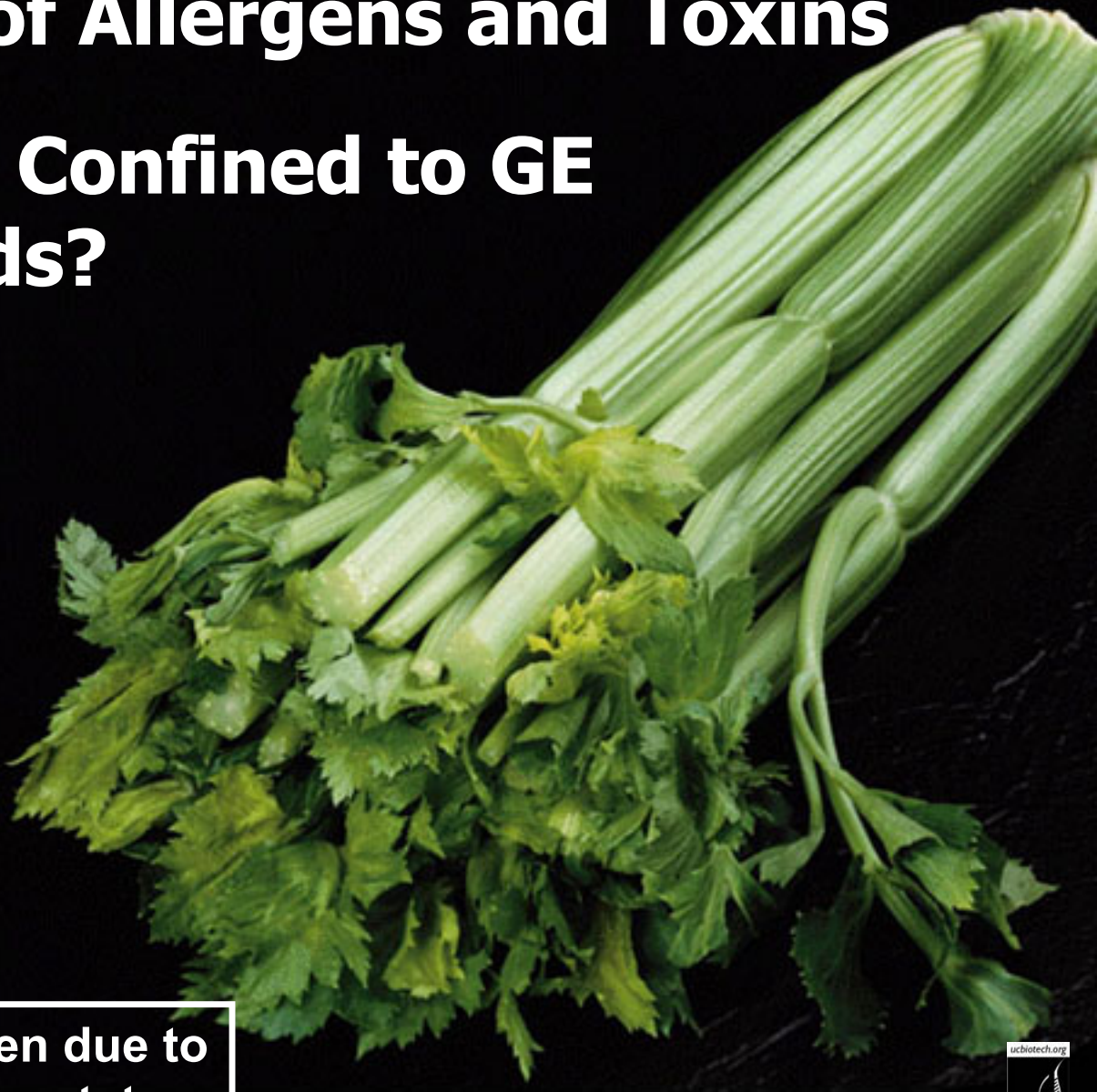
Toxicity Assessment: Roundup Ready/CP4 EPSPS protein

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



Inadvertent Creation of Allergens and Toxins

Is Toxin Creation Confined to GE Foods?



No – naturally occurring toxins happen due to classical breeding efforts also, *e.g.*, potato (glycoalkaloids) and celery (psoralens)

Allergy Creation Confined to GE Foods?

Classically bred foods can cause allergy problems too –

Example: Kiwi

Long-term Food Safety Studies:
Should They Be Done, How
and on What Foods? How long?

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Use Engineering to Reduce Toxins: Fumonisin Reduction with Bt-maize

- 1989: High levels of fumonisin cause large-scale outbreaks of lethal lung edema in pigs, brain tumors in horses
- Fumonisin contamination caused by insect infestation
- 20- to 30-fold fumonisin reduction with Bt-maize

Modified from Drew L. Kershen
University of Oklahoma

SOURCE; Hammond, B. et al., (Feb. 2004), Lower fumonisin mycotoxin levels in the grain of Bt-corn grown in the United States in 2000-2002, J. Agric. Food Chem. 52: 1390-1397

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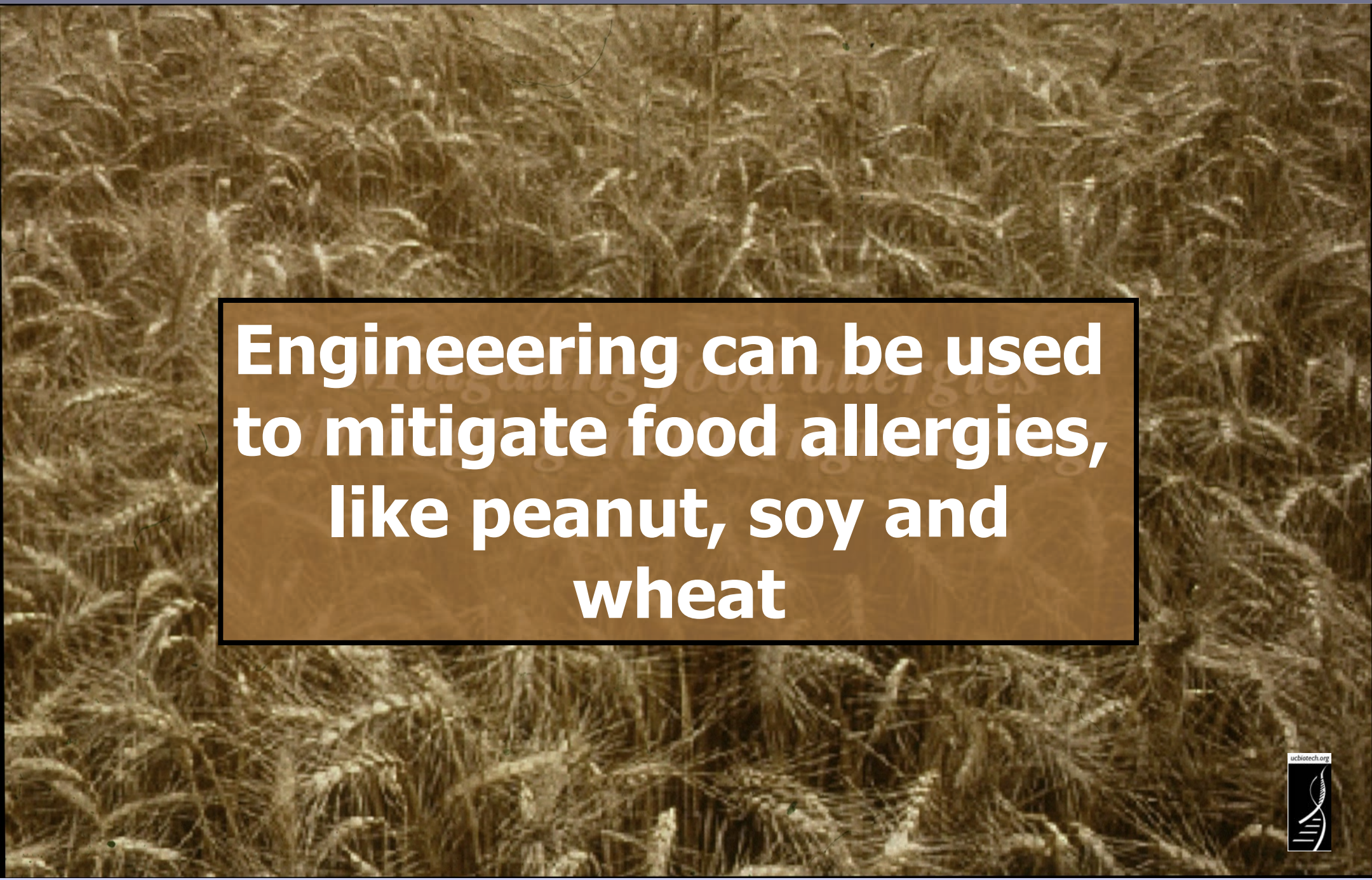
Engineeering can be used to mitigate food allergies, like peanut, soy and wheat
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What are some food safety issues?

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

Why Doesn't FDA Have a Labeling Policy for GM Foods?

Actually it does…

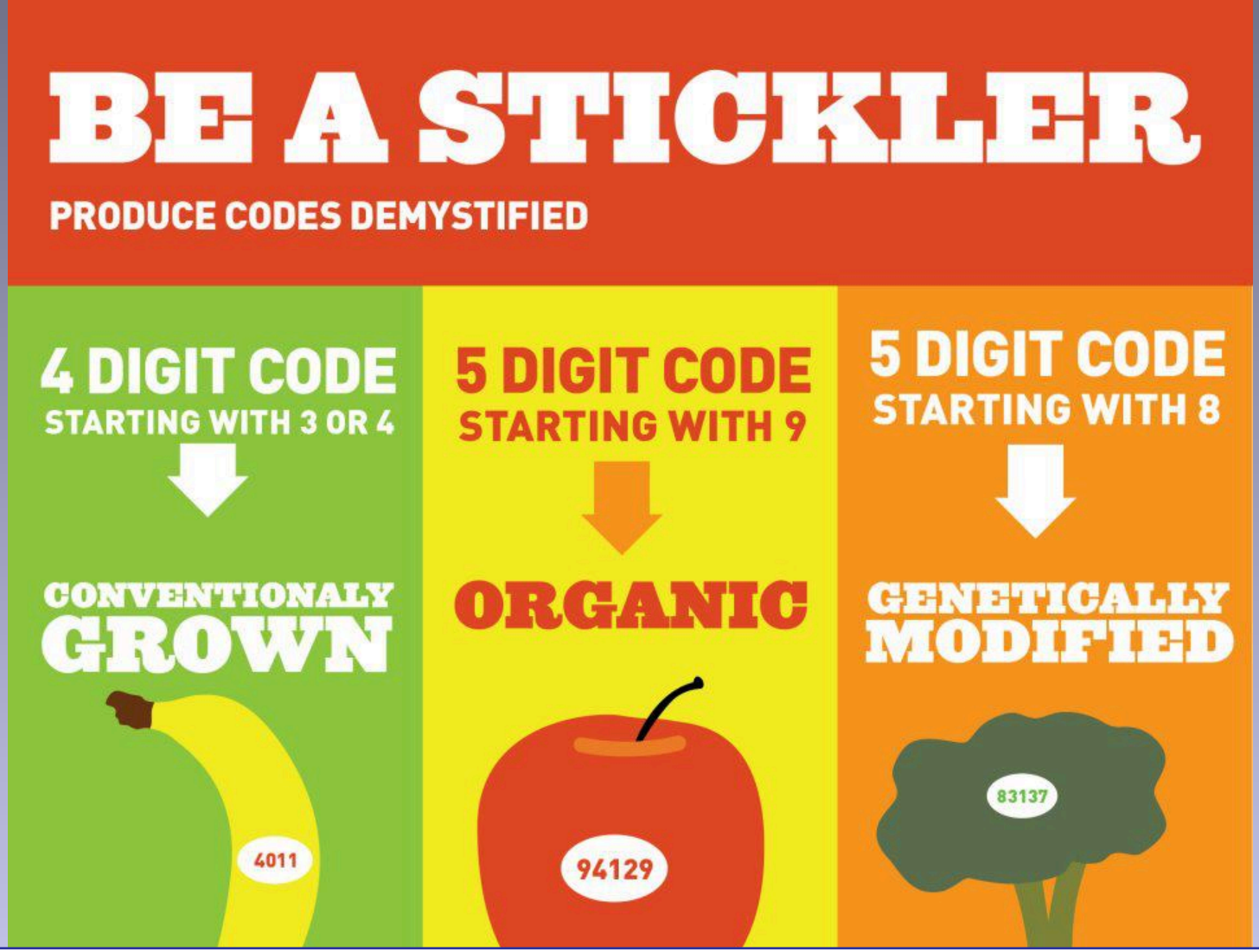
Foods produced through biotechnology are subject to same labeling laws as all other foods and food ingredients

Govt-mandated label information relates to composition or food attributes not agricultural or manufacturing practices

No label needed if food essentially equivalent in safety, composition and nutrition

GM food must be labeled if:

1. Different nutritional characteristics
2. Genetic material from known allergenic source e.g., peanut, egg
3. Elevated levels of antinutritional or toxic compounds



For whole fresh foods, there are existing PLU labels that indicate whether they are GE or organic

National GM Labeling Laws and Policies

Type of GM labeling	Countries that enforce labeling policies	Countries with partially enforced or unenforced labeling policies	Countries with probable plans to introduce a labeling policy
Mandatory	Australia, Brazil, China, European Union, Japan, New Zealand, Norway, Russia, Saudi Arabia, South Korea, Switzerland, Taiwan	Croatia, Ecuador, El Salvador, Indonesia, Malaysia, Mauritius, Serbia, Sri Lanka, Thailand, Ukraine, Vietnam	Nigeria, Uganda, UAE, Zambia
Voluntary	Argentina, Canada, Chile, Hong Kong, Kenya, Philippines, South Africa, USA		Peru

One complicating problem: other nations have specific, labeling laws for GE, although the rules and enforcement vary dramatically among countries, making international trade difficult

SOURCE: Marchant, G.E., Cardineau, G.A. and Redick, T.P. 2010. Thwarting Consumer Choice: The Case against Mandatory Labeling for Genetically Modified Foods. American Entreprise Institute, p. 71.

But, do consumers act on labeling information?

FOOD STANDARDS AGENCY

66% of UK consumers think GE food labeling is important…

But only 2% actively look for GE content when buying foods

SOURCE: "FSA survey: Majority of UK consumers back GM labelling", Food Navigator, January 10, 2013. http://www.foodnavigator.com/content/view/print/728839
Link to report: http://www.food.gov.uk/science/research/ssres/foodsafetyss/gm-labelling/#.UPXkHaHr7jm

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In November 2012 California voted on a Proposition to require mandatory labeling of foods with GE ingredients and restrictions on the use of the term "natural" on food labels.

Capital Press
Agriculture Newspaper

California voters nix biotech labels

Opponents raised $46 million to fight proposition

By ALICIA CHANG
Associated Press

LOS ANGELES — Voters spurned a ballot measure that would have made California the first in the nation to affix labels on breakfast cereals, baked goods and other processed foods containing genetically modified ingredients.

The rejection on Nov. 6 followed an expensive offensive from agri-business and chemical conglomerates, which raised $46 million to blitz airwaves and mailboxes with negative advertising.

We didn't think they'd like the lawsuits, more bureaucracy, higher costs and loopholes and exemptions. It looks like they don't," spokeswoman Kathy Fairbanks said.

Representatives with the California Right to Know campaign tried to put on a positive face.

"No matter what happens, we've raised awareness of a very important issue," said Grant Lundberg, chief executive of Lundberg Family Farms, who co-chairs the California Right to Know campaign.

Consumer activists and the organic food industry said shoppers crave information about what they're eating and should be given all the information they need to decide for them-

After over $40M was spent convincing voters one way or the other, the proposition was defeated 51.4% to 48.6%

appeared pleased.

"We've said from the beginning of this campaign that the more voters learned about Prop 37, the less they'd like it.

al government, which does not require such labels because bioengineered foods are not significantly different in taste, texture and nutrition.

has long harvested corn, cotton, soybean and other plants in which the DNA has been tinkered with in the laboratory to resist pesticides and ward off

into food ingredients found in many cereals, baked goods and sodas.

Despite scientific consensus that genetically modified foods

sumers remain leery and efforts have been mounted to force special labels. Mandatory labeling exists elsewhere, including the European Union.

ing bills, but all failed. A citizen's petition to mark genetically engineered foods nationwide is pending before the U.S. Food and Drug Administration.

SOURCE: "California voters rebuff labels on GMO foods", Capital Press, November 8, 2012
http://www.capitalpress.com/print/AP-CA-Prop-37-Food-labeling-110712

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Organic Bytes

Health, Justice and Sustainability News from the Organic Consumers Association

A weekly e-newsletter edited by Katherine Paul and Ronnie Cummins

ESSAY OF THE WE

GMO Food Fight: Round Two 2013

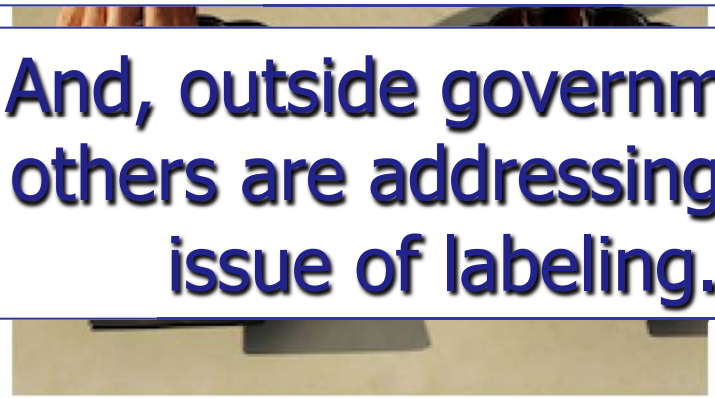
"This gives us hope that you can, with a well funded, well-organized, well-executed campaign, defeat a ballot initiative and go directly to the voters. We hope we don't hav too many of them, because you can't keep doing that over and over again . . .".

- Jennifer Hatcher, Food Marketing Institute, on Big Food and Big Biotech's narrow defeat of Prop 37, the California Right to Know GMO ballot initiative.

End of Story?

Not likely in California, nor a number of other states, like Washington, Oregon, Vermont…

And, outside government, others are addressing the issue of labeling.



, 2013

http://www.organicconsumers.org/bytes/ob361.htm

WHOLE FOODS MARKET

By 2018, all products in U.S. and Canadian stores must be labeled to indicate whether they contain genetically modified organisms (GMOs)

The New York Times

March 8, 2013

Major Grocer to Label Foods With Gene-Modified Content

By STEPHANIE STROM

Whole Foods Market, the grocery chain, on Friday became the first retailer in the United States to require labeling of all genetically modified foods sold in its stores, a move that some experts said could radically alter the food industry.

A variety of companies are becoming involved in different ways in GMO labeling.

grown in the United States, for example, have been genetically modified. The alterations make soybeans resistant to a herbicide used in weed control, and causes the corn to produce its own insecticide. Efforts are under way to produce a genetically altered apple that will spoil less quickly,

SOURCE: "Major Grocer to Label Fodos With Gene-Modified Content", New York Times, 3/8/13
http://www.nytimes.com/2013/03/09/business/grocery-chain-to-require-labels-for-genetically-modified-food.html?ref=opinion&_r=0

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THE HUFFINGTON POST

GMO Labeling Bill Voted Down In Senate

Posted: 05/23/2013 11:31 am EDT | Updated: 05/23/2013 4:08 pm EDT

WASHINGTON -- The United States Senate decided again Thursday that it simply does not want to let states tell people whether or not they are

And now the labeling issue has moved to the national stage…via numerous proposed bills and amendments

If a decision at the national level is not made – in some way or another – there will be a potpourri of state labeling bills that will make interstate commerce very problematic- similar to existing issues with international trade.

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Consider that 75% of U.S. processed foods have GE ingredients. If mandatory labeling laws were enacted, either manufacturers would have to find alternatives to the GE ingredients – which might be difficult – or the vast majority of processed foods would be labeled that they "contain" or "may contain genetically engineered ingredients"

While the fresh food aisle would change little, the majority of foods in the processed food aisle could contain "warning labels" about GE ingredients.

Consider the following…

KQED
SCIENCE

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

- ***Prop 65 originally passed to protect citizens of CA from toxic substances***
- ***Often well-meaning and effective, it resulted in frivolous lawsuits. Example: lawsuit against banks for not posting Prop 65 warnings on ATM machines as users might smoke nearby and "contaminate" people using ATM***
- ***Prop 65 warning signs so prevalent that signage has become meaningless***
- ***Could be similar with signage for GE foods: label indicating "may contain genetically engineered ingredient" would become so common it could become meaningless and ignored***

SOURCE: "Governor Vows to End Prop. 65 'Shakedown' Suits", KQED, 5/8/13
www.kqed.org/news/story/2013/05/08/120535/governor_vows_to_end_prop_65_shakedown_suits?category=science

Why not just label?

Putting a label on a whole food is relatively easy, but…

...processed foods are different. Tomato sauce contains

many varieties – a GM variety would have to be tracked to assure correct content information, depending on type of label required.

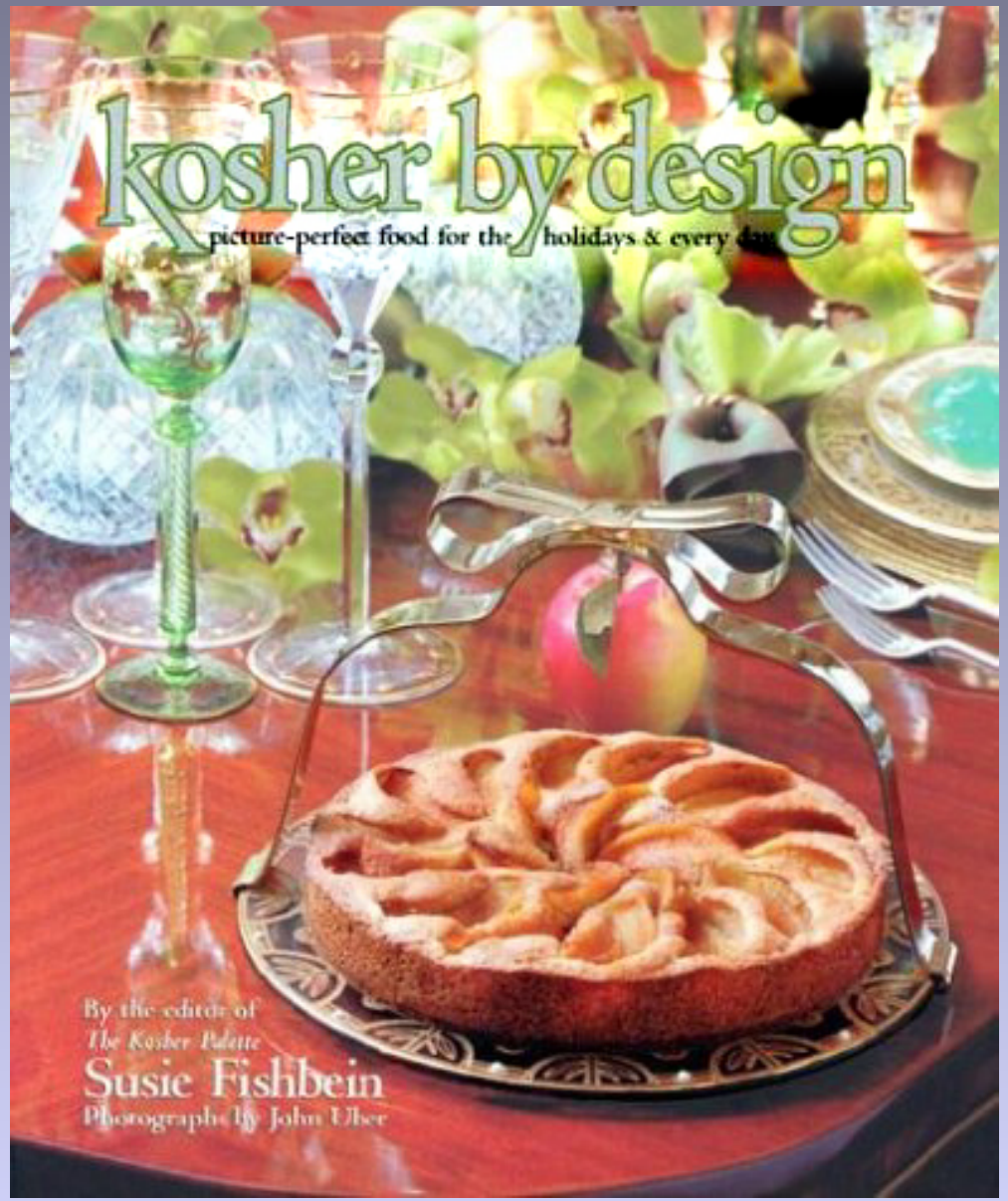
May contain genetically modified tomatoes

Contains genetically modified tomatoes

But there are foods that are tracked for consumer choice… like organic and…

...Kosher

For which people pay premium prices



Should everyone pay a premium price for GE-free foods if there are no food safety or nutritional differences?

Might another solution be…

If there is demand, might another solution be to allow the creation of a specialty market for GE-free foods for which people pay a premium price and for which farmers are paid premium prices to grow them?

(Lemaux, 2002)

The Washington Post

Food industry seeks voluntary GMO labeling

By Associated Press, Published: February 6

WASHINGTON — People who want to know more about genetically modified ingredients in their food would be able to get it on some packages, but not others, under a plan the industry is pushing.

Large food companies worried they might be forced to add "genetically modified" to packaging are proposing voluntary labeling of those engineered foods, so the companies could decide whether to use them or not.

The effort is an attempt to head off state-by-state efforts to require mandatory labeling. Recent ballot initiatives in California and Washington state failed, but several state legislatures are considering labeling requirements, and opponents of engineered ingredients are aggressively pushing for new laws in several states.

The move comes as consumers demand to know more about what's in their food. There's very little science that says genetically engineered foods are unsafe. But opponents say there's too much unknown about seeds that are altered in labs to have certain traits, and that consumers have a right to know if they are eating them. The seeds are engineered for a variety of reasons, many of them to resist herbicides or insects.

"Food industry lobbying for bill requiring FDA to create voluntary labels for GE foods and to require safety review of GE foods before being sold"
(February 2014)

SOURCE: "Food industry seeks voluntary GMO labeling", Washington Post, February 6, 2014.
http://www.washingtonpost.com/politics/federal_government/food-companies-propose-voluntary-gmo-labels/2014/02/06/78d2487c-8f4e-11e3-878e-d76656564a01_story.html

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Now to some environmental issues?

- Transfer of engineered genes to non-GMO/ organic crops?
- Development of herbicide-tolerant weeds or pesticide-resistant insects
- Spread of pharmaceutical genes into commercial crops?
- Loss of genetic diversity?
- Property rights (gene patents)?

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Can Organic Agriculture Coexist with GE Crops?

What is Co-existence

- ***Development of best management practices to minimize adventitious presence of unwanted material***

- ***Effectively enable different production systems to co-exist to ensure sustainability and viability of all production systems***

- ***Establish reasonable standards for allowable levels of adventitious presence***

Capital Press, September 16, 2005

Communicate to avoid pesticide drift, winemaker says

This is not the first time coexistence between conventional and organic agriculture has been an issue.

By MATEUSZ PERKOWSKI
Freelance Writer

Fifteen years ago, David Adelsheim received some bad news. His vineyard manager had noticed

MATEUSZ PERKOWSKI/For the Capital Press

David Adelseheim 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.

was overgrown with blackberry bushes with a growth regulator herbicide containing 2,4-D. Aside from 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

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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)

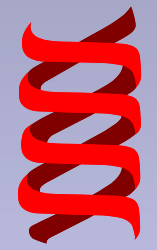
- they "...include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture."

F.J. Chip Sundstrom CCIA

…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**

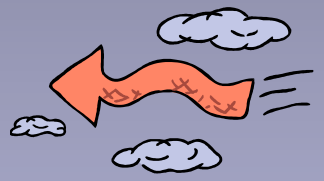
Are There Tolerances for GE in Organic Products?



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

There are tolerances for pesticides but not for GM 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

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CAST® Issue Paper
Number 49
February 2012

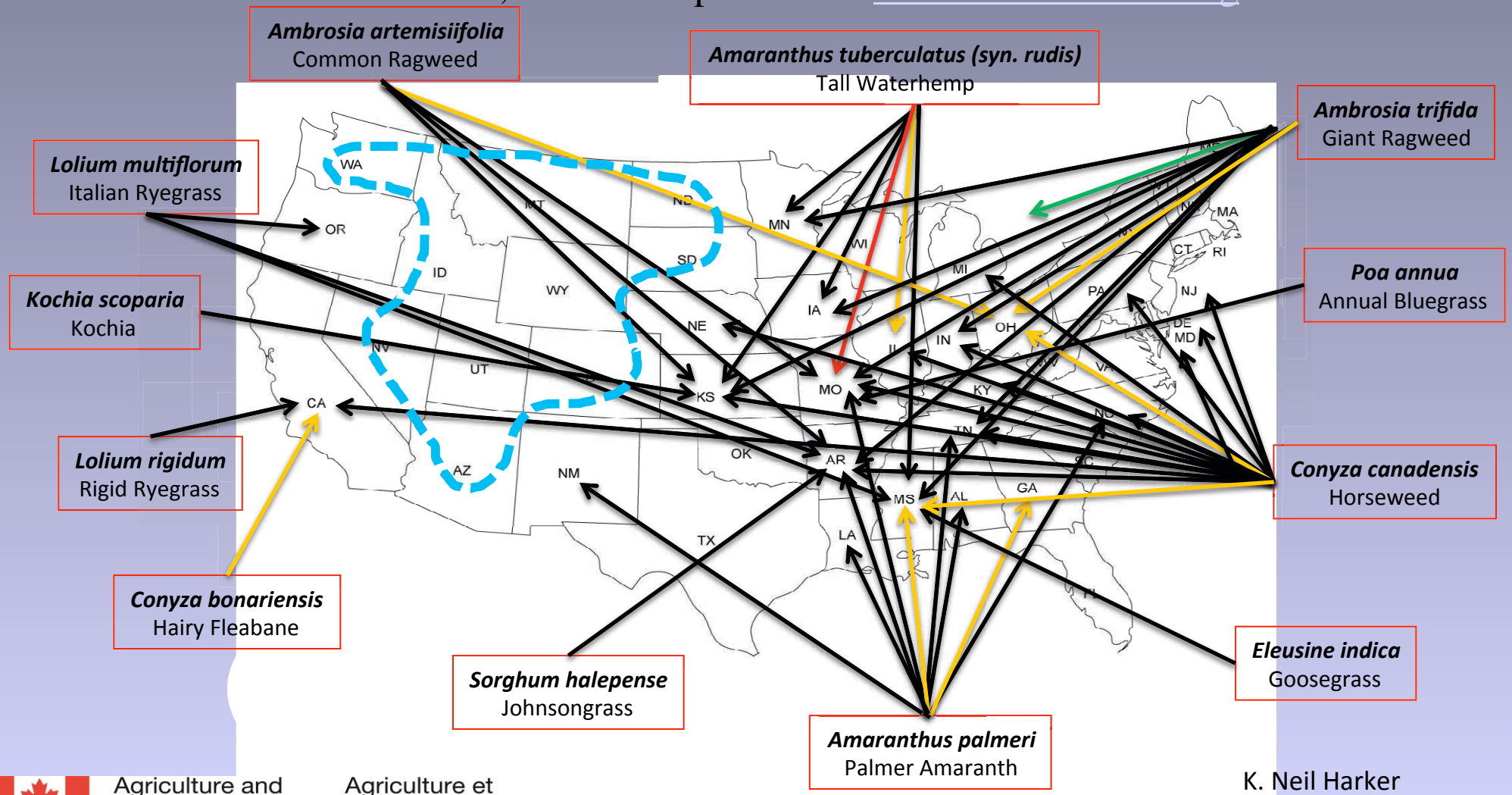
"When any single herbicide mechanism of action is used repeatedly without alternative management tactics, however, selection pressure becomes intense for plants that are tolerant or resistant to that herbicide."

"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/qOAXOq

Glyphosate- Resistant Weeds – USA

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



Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

K. Neil Harker
AAFC - Lacombe, AB

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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 in San Luis Obispo 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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Capital Press
Agriculture Newspaper

Investigative report

Monsanto's practices weed out competition

Licensing pacts, science propel seed company to dominate position

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

Dan Gill/Associated Press

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.

Companies have taken the lead in creating today's commercial GE crops and control most of the key intellectual property, making it difficult for small companies or the academic sector to play a meaningful role in addressing agricultural challenges with genetic engineering.

SOURCE: Capital Press, December 18, 2009

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Capital Press
Agriculture Newspaper

US regulators examine competition in agriculture

By CHRISTOPHER LEONARD
Associated Press

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

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

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 ball-

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

side to open the hearing, called the workshop an unprecedented act of cooperation between their 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

try production.

Those in the audience at the hearing paid keen attention, trying 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

cession and stifle innovation and investment.

Holder and Vilsack said it's not clear yet what actions will 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

suffers.

"This is not just about farmers and ranchers," Vilsack said. "It's really 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-

Chuck Grassley, R-Iowa, Iowa Attorney General Tom Miller and others outlined their concerns about consolidation in 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."

SOURCE: Capital Press, March 19, 2010

Recent U.S. Supreme Court had an important impact on how patents will play out in the U.S. Justices rendered unanimous decision indicating that patent exhaustion does not permit a farmer to reproduce patented seeds through planting and harvesting without patent holder's permission

If this decision had gone the other way, the patent landscape would have changed dramatically.

SOURCE: "Supreme Court Supports Monsanto in Seed-Replication Case", New York Times, 5/13/13
http://www.nytimes.com/2013/05/14/business/monsanto-victorious-in-genetic-seed-case.html

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Where to get more information on the issues?

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