Are we using GMOs wisely?

Steve Strauss
Oregon State University
Steve.Strauss@OregonState.Edu

Agenda

- Where do you stand?
  - Orientation to issues
- GMO literacy
  - Crop domestication/breeding
  - GE method
  - GE product examples
- Indications of wisdom
  - Regulations
  - Management of current GM crops
  - Obstruction by proliferation of myths, stigmatizing labels

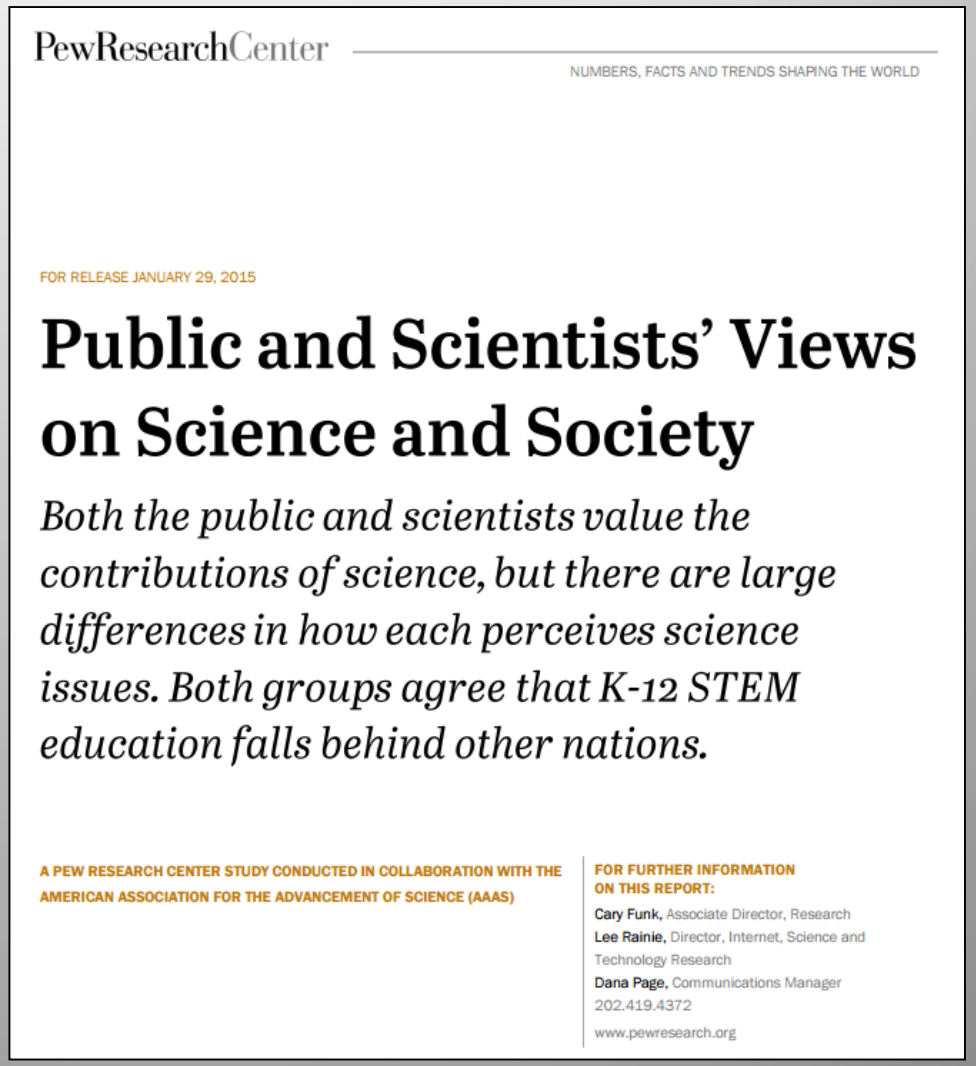
We using GMOs wisely

A. Strongly disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly agree

It is generally safe/unsafe to eat genetically modified foods

A. Safe
B. Unsafe

Pew Survey on views of controversial science issues - 2015



PewResearchCenter

NUMBERS, FACTS AND TRENDS SHAPING THE WORLD

FOR RELEASE JANUARY 29, 2015

Public and Scientists' Views on Science and Society

Both the public and scientists value the contributions of science, but there are large differences in how each perceives science issues. Both groups agree that K-12 STEM education falls behind other nations.

A PEW RESEARCH CENTER STUDY CONDUCTED IN COLLABORATION WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)

FOR FURTHER INFORMATION ON THIS REPORT:

Cary Funk, Associate Director, Research

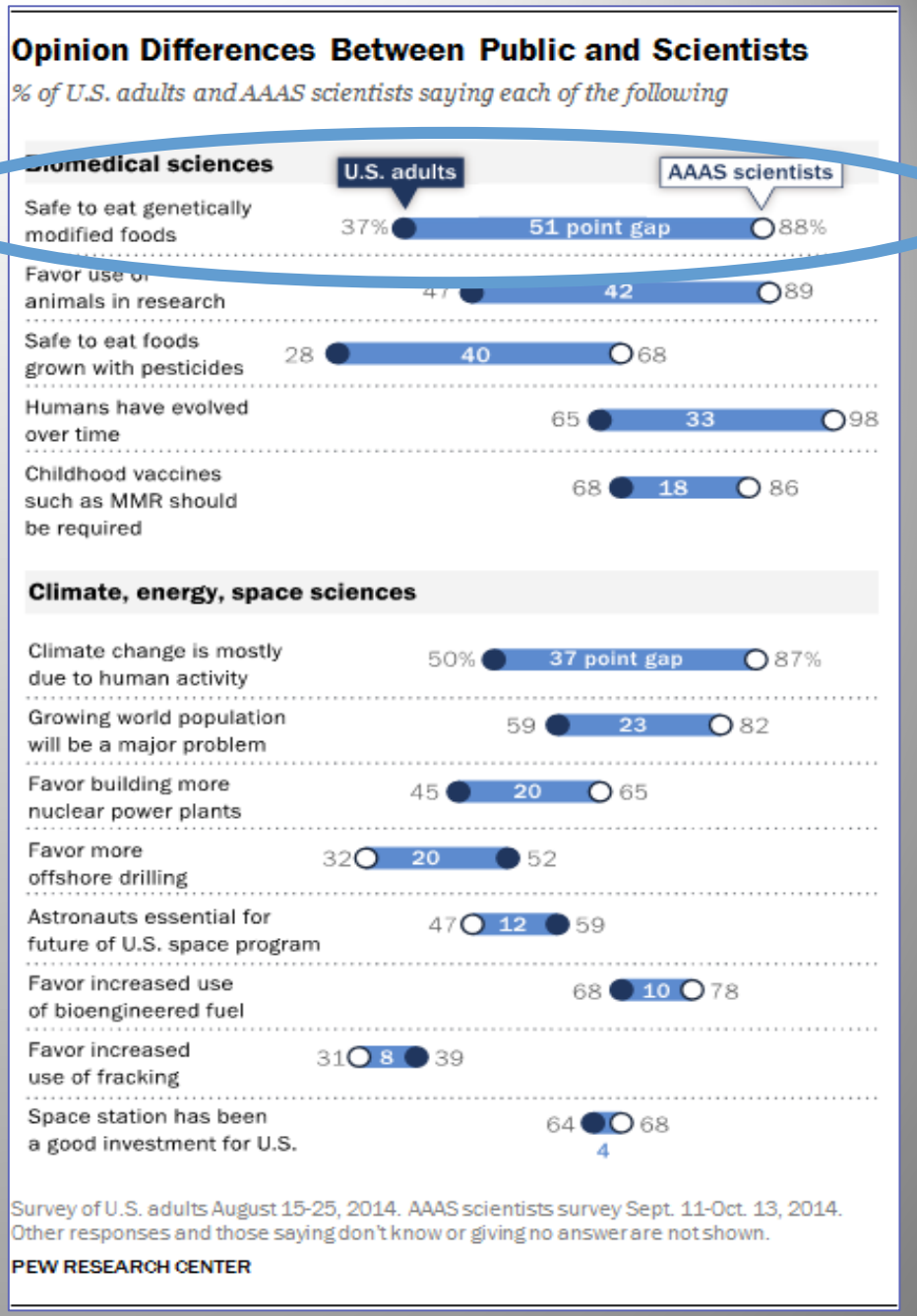
Lee Rainie, Director, Internet, Science and Technology Research

Dana Page, Communications Manager

202.419.4372

www.pewresearch.org

http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/



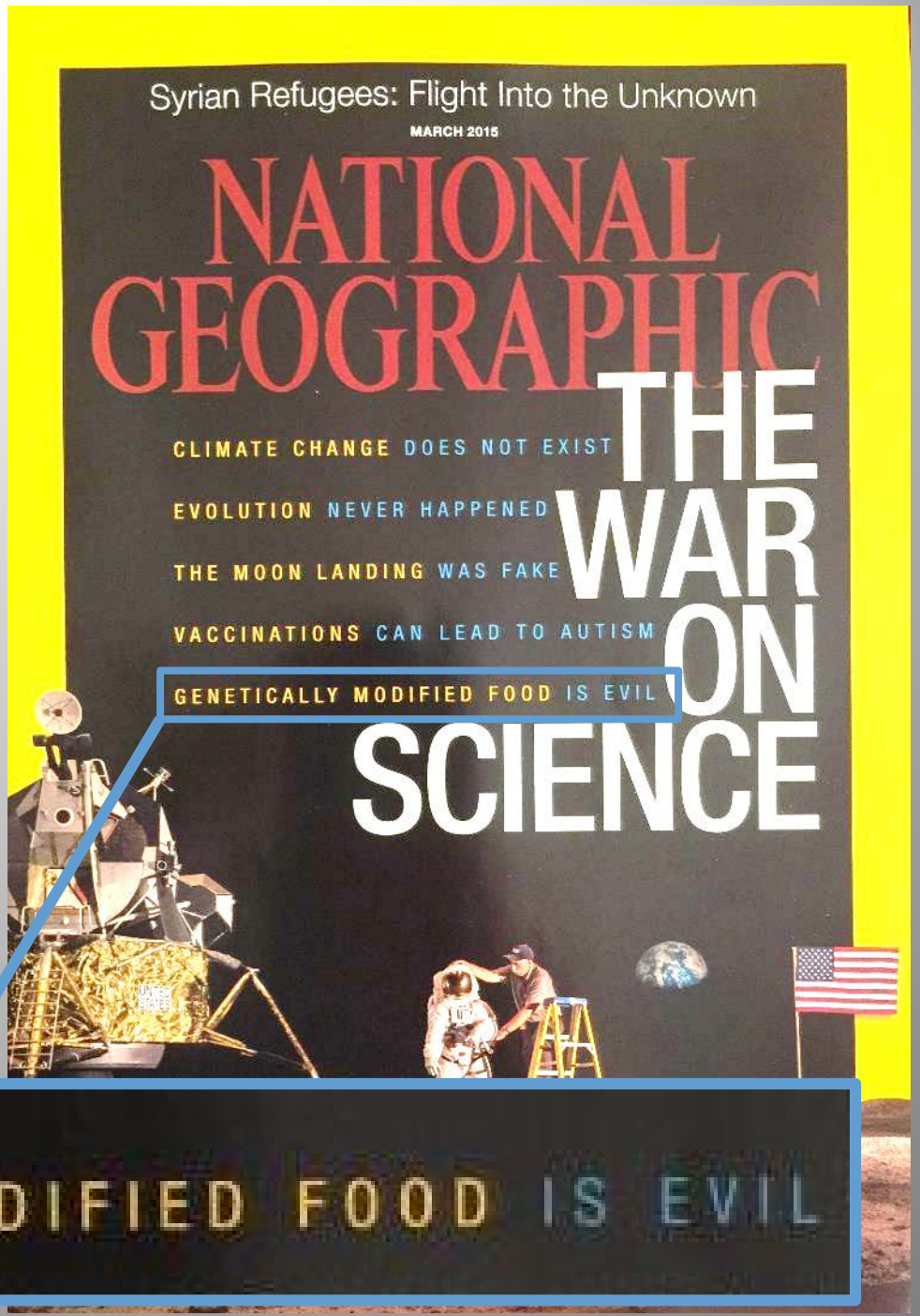
GMOs the largest scientist-public gap, 51%, of any issue surveyed

http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/

My goal

Speaking as scientist, and seeking to reflect what mainstream science is thinking and saying

It’s hard to tell what science is saying amidst all the noise



GENETICALLY MODIFIED FOOD IS EVIL

Mainstream science is supportive of responsible uses of GMOs

American Society of Plant Biologists

Cultivating a better future through plant biology research.

REVISED POSITION STATEMENT ON PLANT GENETIC ENGINEERING

Advances in agriculture are cumulative and build on the integration of new approaches with established breeding techniques and farming practices. The Food and Agricultural Organization anticipates the need for a 70% increase in agricultural productivity to meet the food, feed, fiber and fuel needs of an ever-growing world population, without further degrading the environment

The American Society of Plant Biologists (ASPB) supports the continued responsible use of genetic engineering (hereafter referred to as GE) as an effective tool for advancing food security and reducing the negative environmental impacts of agriculture. ASPB also supports the

and reducing the negative environmental impacts of agriculture. ASPB also supports the
continued use and further development of appropriate, science-based procedures and regulations

The use of GE to modify plants represents an important advance in plant science and agriculture that builds on centuries of human involvement in the genetic modification of crop species. GE

The use of GE to modify plants represents an important advance in plant science and agriculture that builds on centuries of human involvement in the genetic modification of crop species. GE
allows for the transfer into a plant of well-characterized genes. The precision of this technology, coupled with the knowledge of the specific nature of the manipulated genetic information, makes the risks of unintended consequences of this type of gene transfer comparable to or less than the random mixing of genes that occurs during classical breeding (National Research Council, 2004).

Revised 2014

AAAS: Position on GMO labeling

“Legally mandating such a label can only serve to mislead and falsely alarm consumers”

Statement by the AAAS Board of Directors On Labeling of Genetically Modified Foods

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

20 October 2012

There are several current efforts to require labeling of foods containing products derived from genetically modified crop plants, commonly known as GM crops or GMOs. These efforts are not driven by evidence that GM foods are actually dangerous. Indeed, the science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe. Rather, these initiatives are driven by a variety

conclusion: consuming foods containing ingredients derived from GM crops is no riskier than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques.

Civilization rests on people's ability to modify plants to make them more suitable as food, feed and fiber plants and all of these modifica-

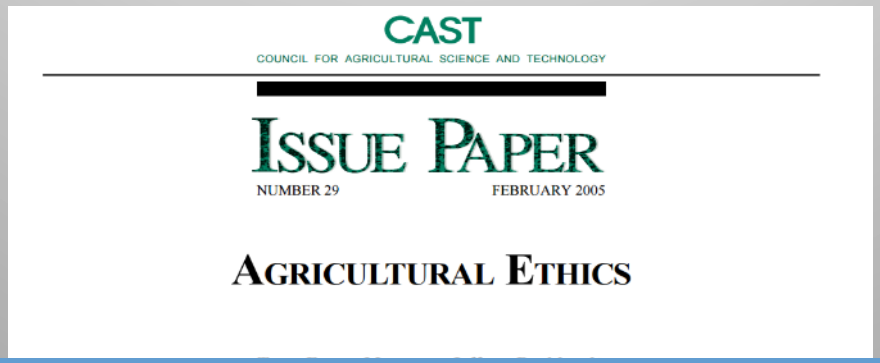
added, the protein must be shown to be neither toxic nor allergenic. As a result and contrary to popular misconceptions, GM crops are the most extensively tested crops ever added to our fo
occasional claim
foods to animals
ranging from dig
to sterility, tumo
death. Although such claims are often sensationalized and receive a

Approved by the AAAS Board of Directors on 20 October 2012

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

The GMO controversy is complex: There are many pieces

- *"It is accurate to say that many of the real ethical issues [of GMOs in agriculture] have little to do with the use of transgenic technologies"* (Burkardt et al. 2005, Agricultural Ethics, CAST)


CAST

COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY

ISSUE PAPER

NUMBER 29 FEBRUARY 2005

AGRICULTURAL ETHICS

But GMO is a scientific definition – we need to get the science right when we consider the intersecting issues

Why do GMOs matter to you?

- Wish to see wise use of a critical technology for food, medicine, and energy production in a highly insecure world, especially for the poor
- Smart (safe, ethical, economic) food choices for you and your family
- Conflicting information about them is widespread in marketplace and online – I want truth
- Not being duped by costly but unfounded greenwash and natural food claims

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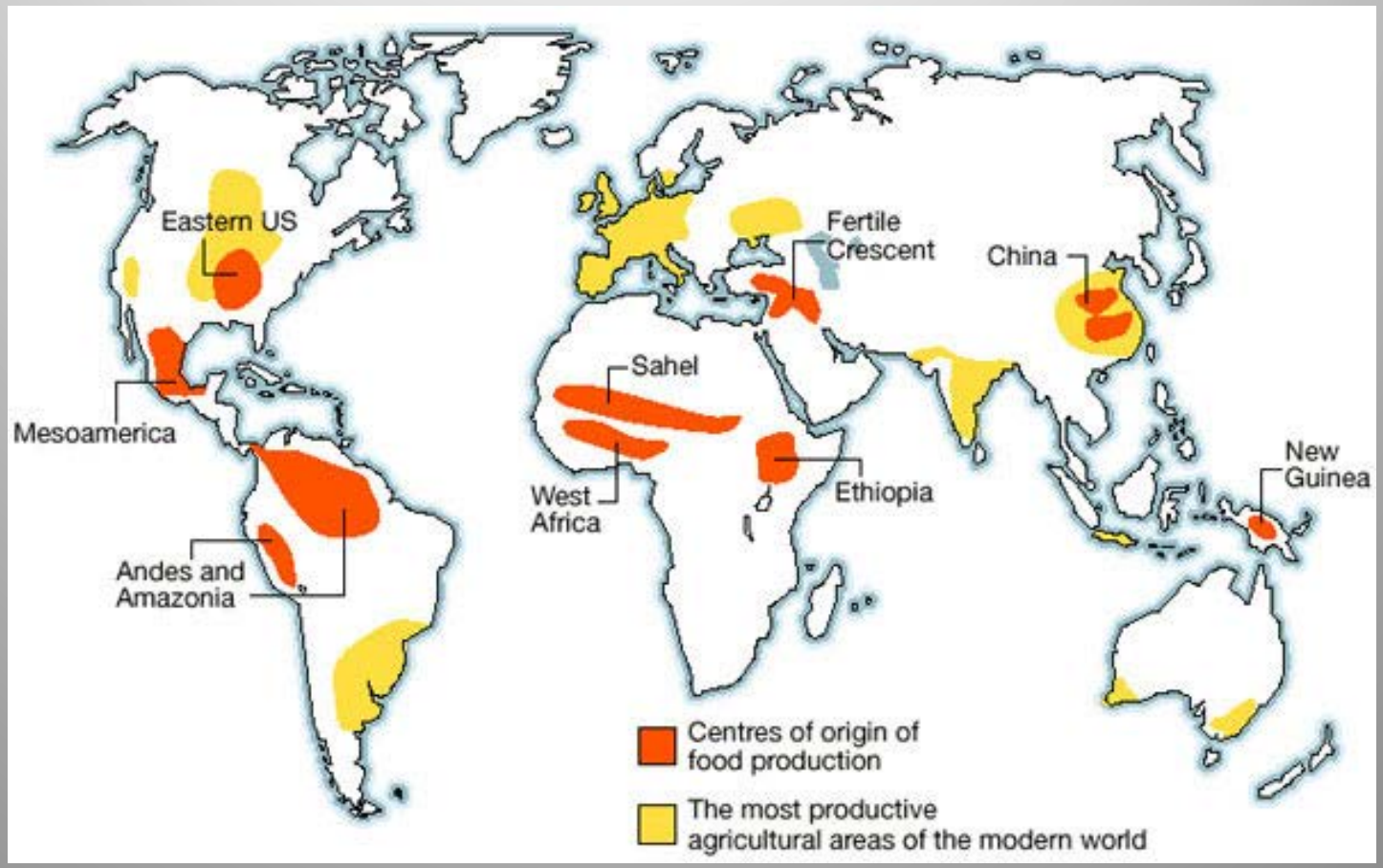
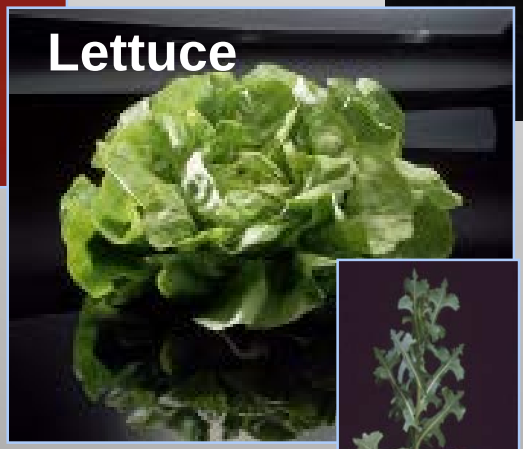
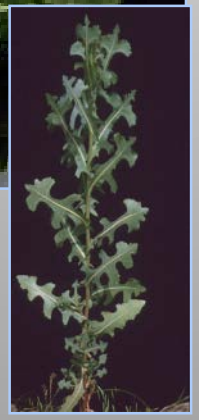
Crops were domesticated in parallel in several regions of the globe – then moved and further bred all over the world



A few of the major modifications made

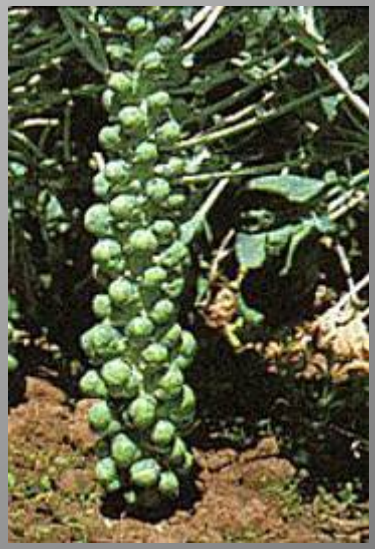




Radical changes in form: Diversity of crucifer crops derived from wild cabbage

Kohlrabi
Germany, 100 AD

Ornamental kale
Late 1900's



Brussel sprouts
Belgium, 1700's

Many plant varieties derived from induced mutations

Over 3,000 crop varieties derived from mutagenesis have been commercialized

Calrose 76 semi-dwarf rice

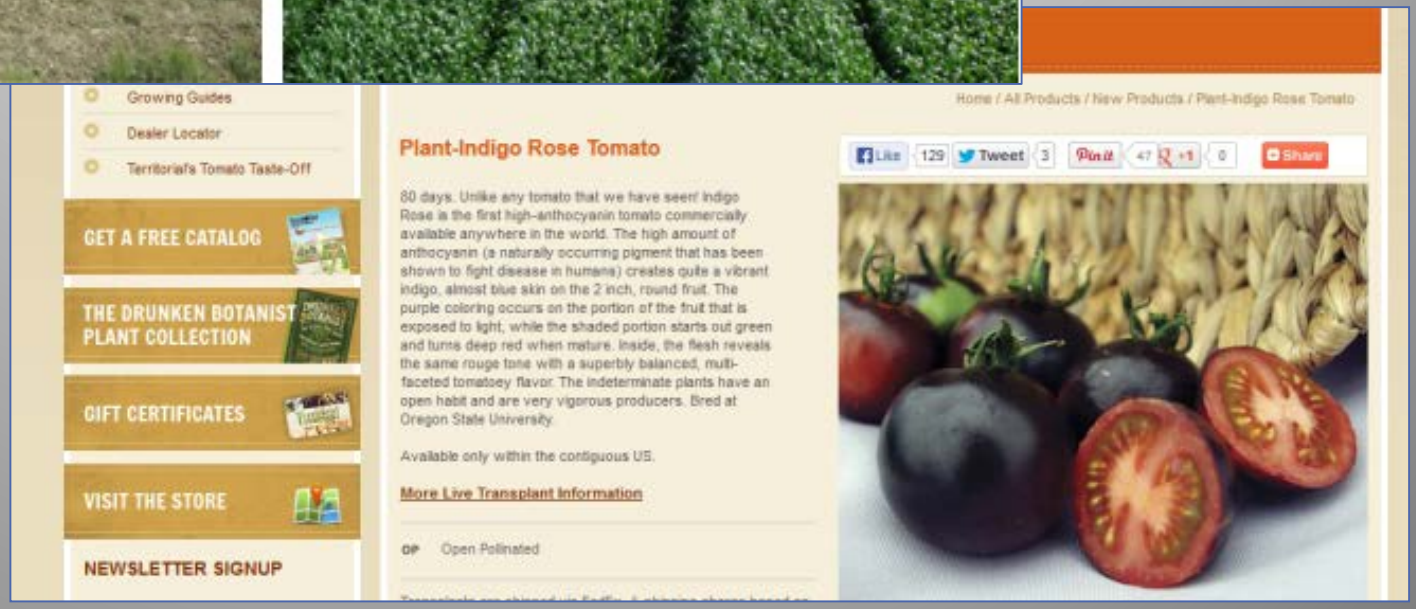
High oleic sunflower

Rio Red grapefruit

Radical changes in domesticated animals

All dogs derived from the wolf by breeding

Breeding continues -- accelerating in age of massive DNA sequencing



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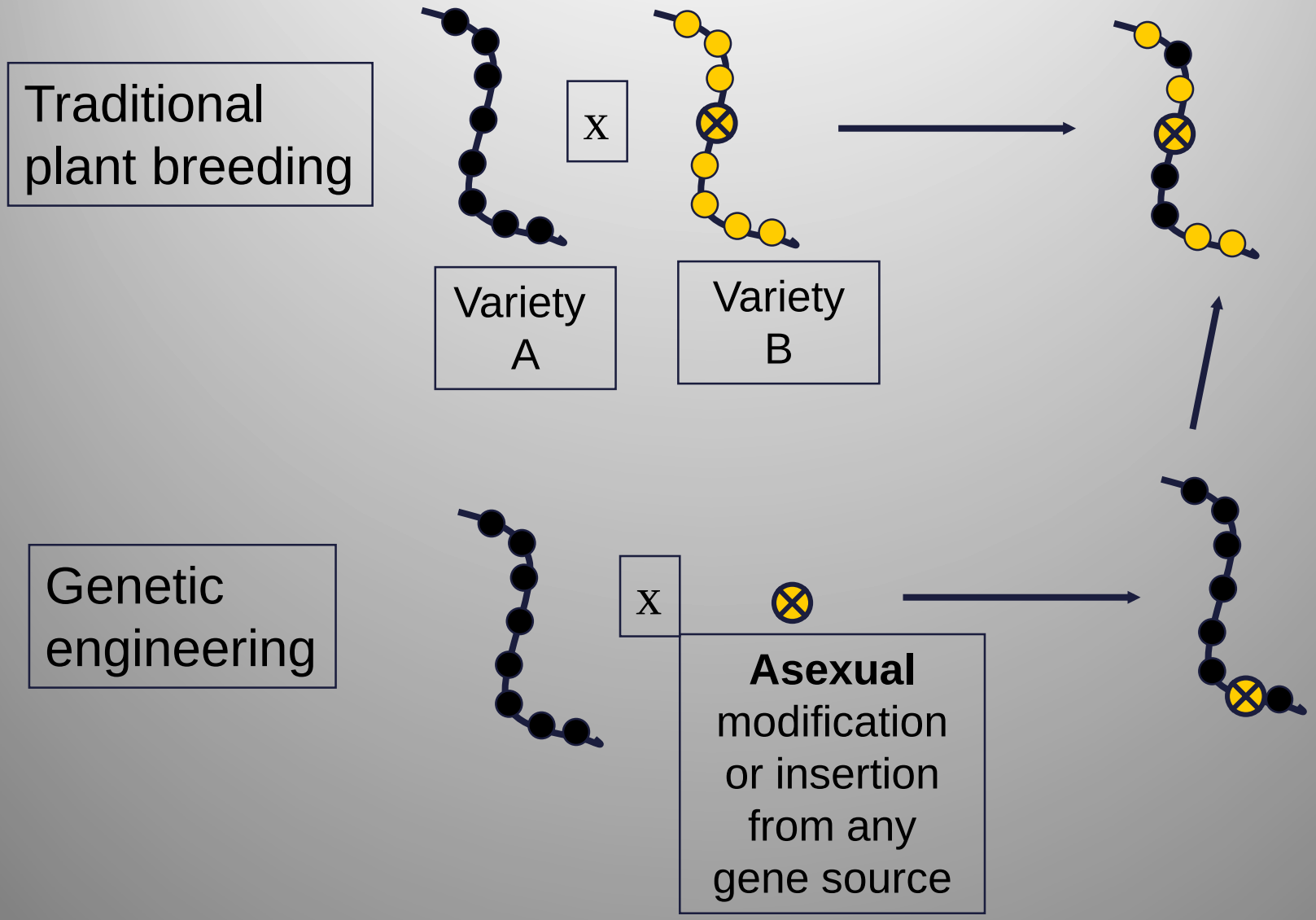
GMO refers to a method of breeding with diverse outcomes



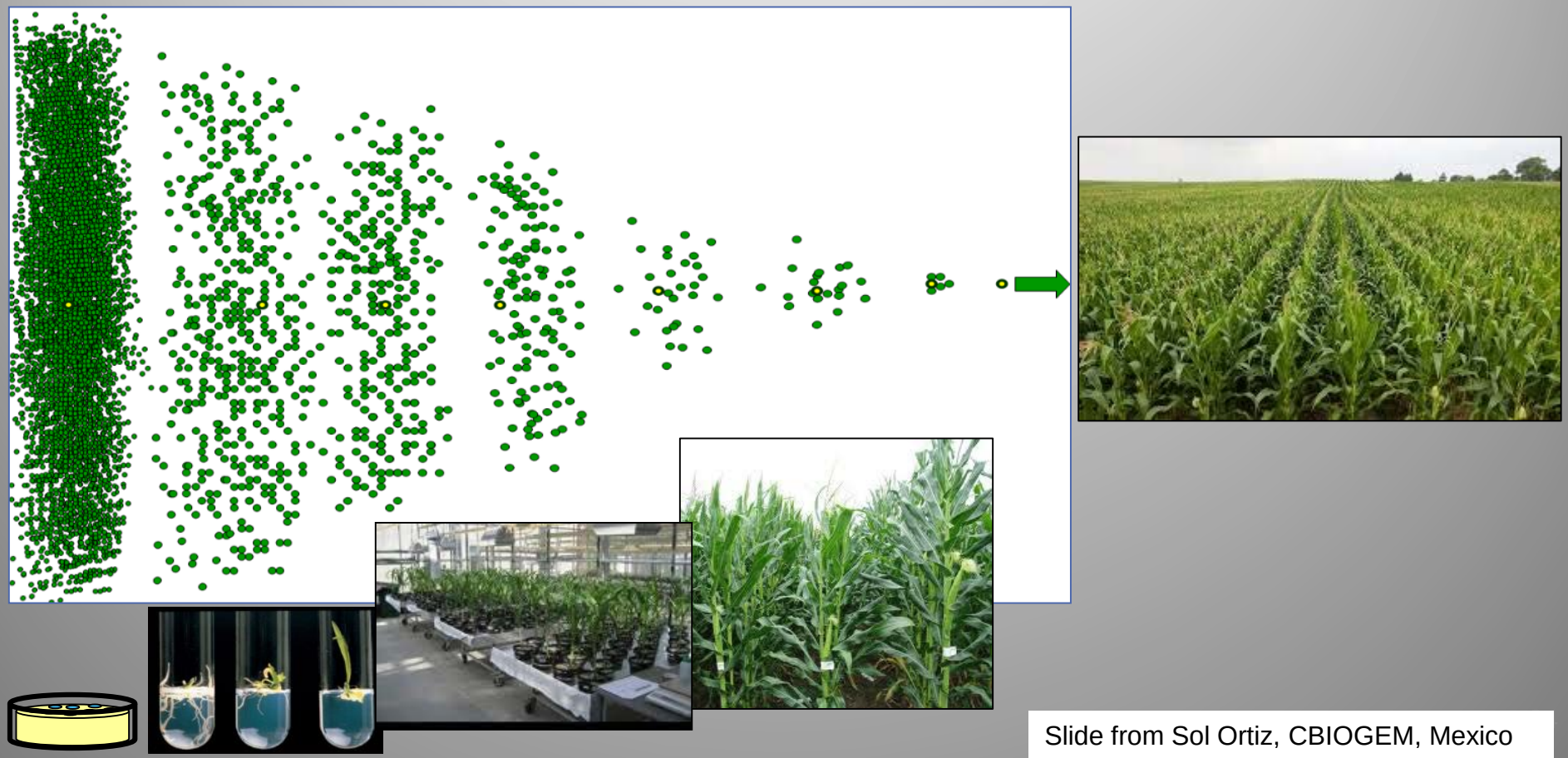
After cells are modified, they are induced to regenerate into whole plants

Then propagated normally (seeds, cuttings) and tested for health and new qualities, incorporated into breeding programs

Propagation in tissue culture

Growth in the field

Commercial GMO crops selected from many dozens to hundreds of insertions after testing and breeding for safety, performance, stability



Slide from Sol Ortiz, CBIOGEM, Mexico

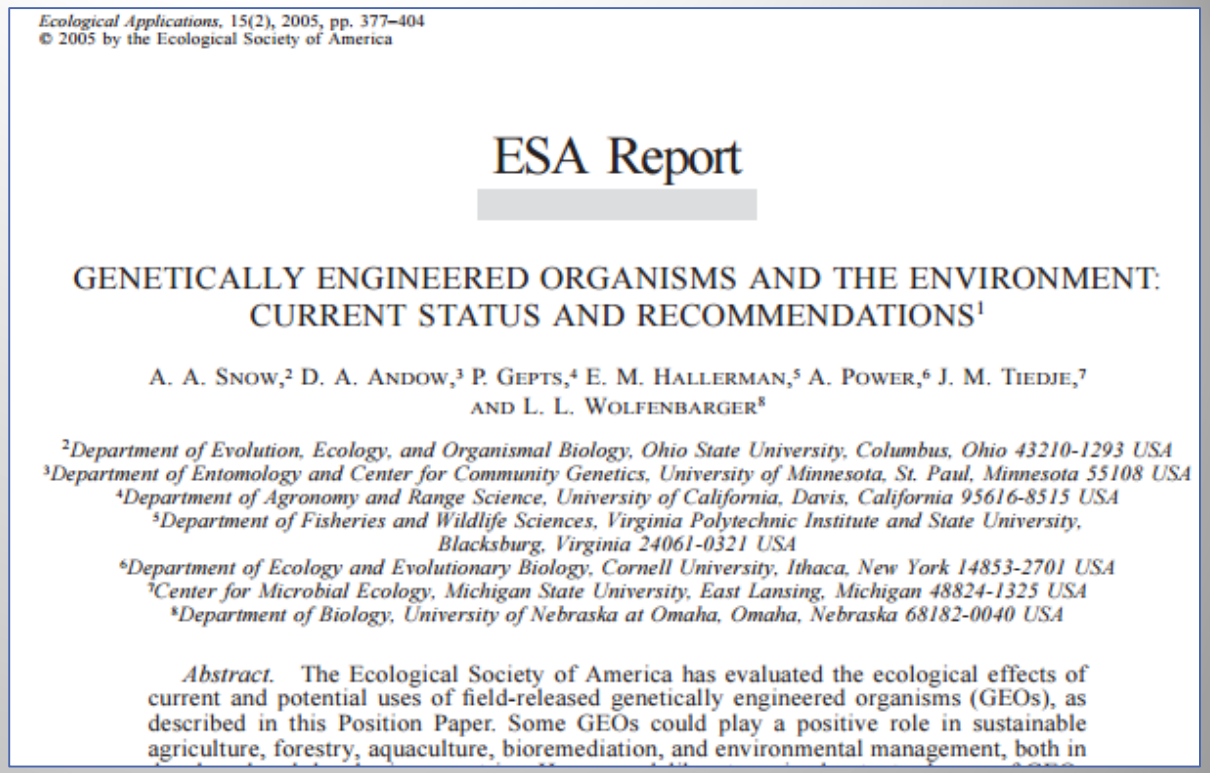
GE a technology with diverse outcomes, including many…..

- Genes/traits - Types of crops - Places
- Values - Approaches

- More like a wheel or computer than a medicine or saxophone

- **“Product not process,” “case by case,”** is global consensus for science assessments

GMOs are diverse: Product not process consensus among scientists



Ecological Applications, 15(2), 2005, pp. 377–404

ESA Report

GENETICALLY ENGINEERED ORGANISMS AND THE ENVIRONMENT: CURRENT STATUS AND RECOMMENDATIONS[1]

A. A. Snow,[2] D. A. Andow,[3] P. Gepts,[4] E. M. Hallerman,[5] A. Power,[6] J. M. Tiedje,[7] and L. L. Wolfenbarger[8]

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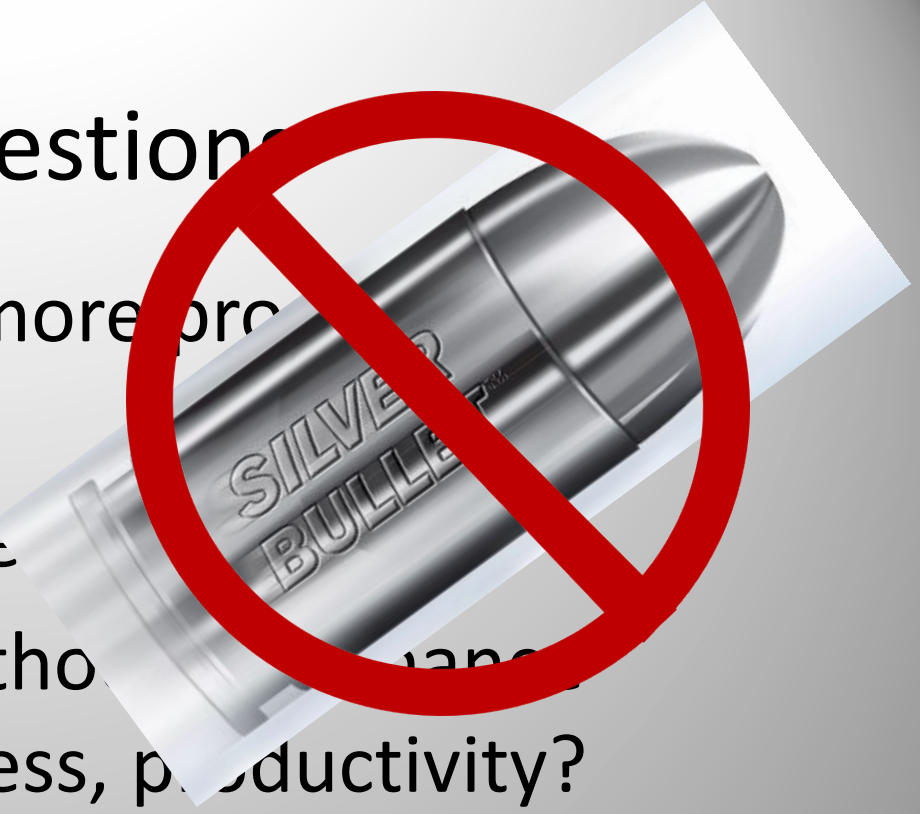
[3]*Department of Entomology and Center for Community Genetics, University of Minnesota, St. Paul, Minnesota 55108 USA*
[4]*Department of Agronomy and Range Science, University of California, Davis, California 95616-8515 USA*
[5]*Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061-0321 USA*
[6]*Department of Ecology and Evolutionary Biology, Cornell University, Ithaca, New York 14853-2701 USA*
[7]*Center for Microbial Ecology, Michigan State University, East Lansing, Michigan 48824-1325 USA*
[8]*Department of Biology, University of Nebraska at Omaha, Omaha, Nebraska 68182-0040 USA*

Abstract. The Ecological Society of America has evaluated the ecological effects of current and potential uses of field-released genetically engineered organisms (GEOs), as described in this Position Paper. Some GEOs could play a positive role in sustainable agriculture, forestry, aquaculture, bioremediation, and environmental management, both in

"We reaffirm that risk evaluations of GEOs should focus on the phenotype or product rather the process of genetic engineering …"

The more relevant questions

- Is agriculture becoming more pro… sustainable, resilient?
- If food becoming healthie…
- Are we using genetic metho… …ane… sustainability, healthfulness, p…oductivity?
- There are no silver bullets: Are we making intelligent choices, management tactics, and tradeoffs to move in the right direction ?



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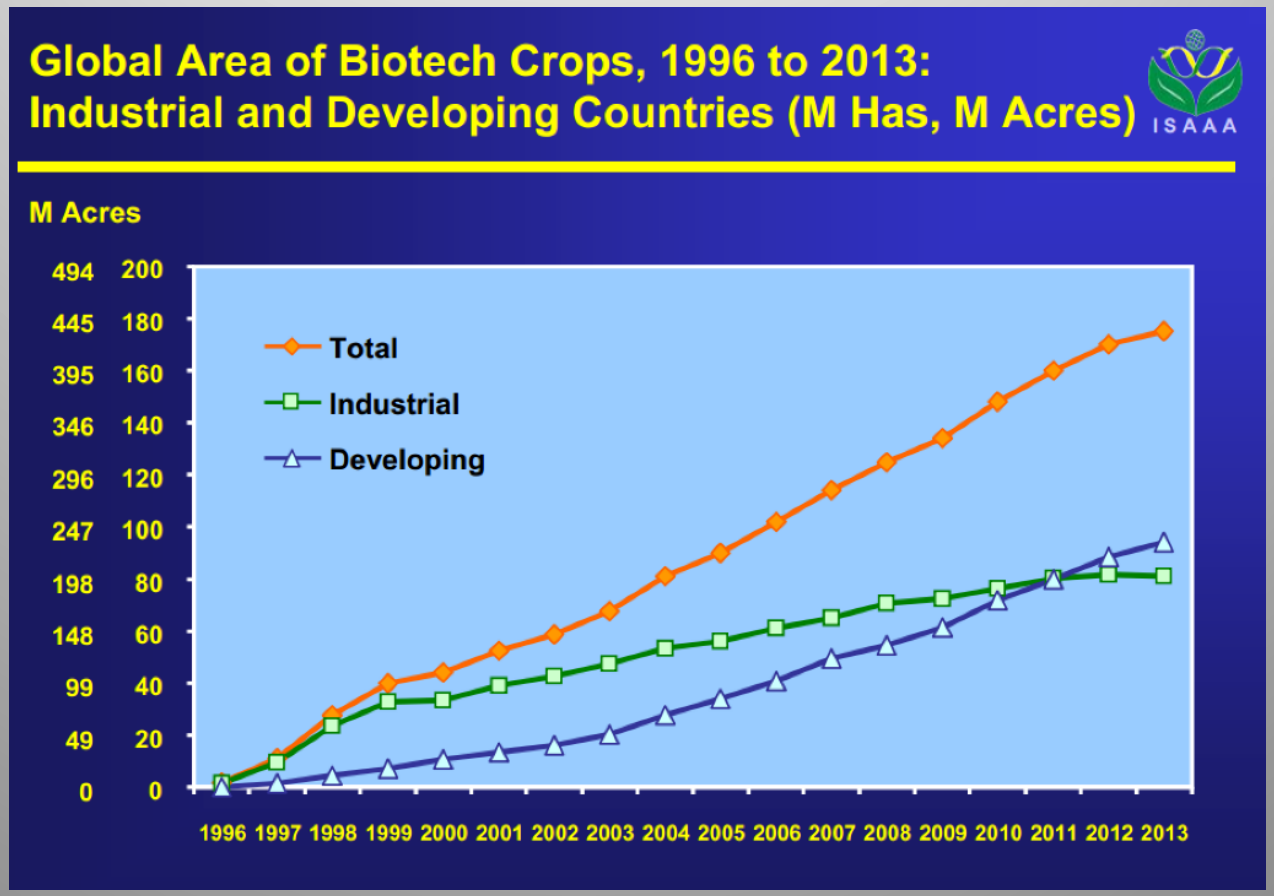
First generation herbicide and insect resistant crops were rapidly adopted by farmers, both in the developed and developing world



GMOs add a lot of value to the economy, environment

If removed, lower yields (~5-19%), higher prices ($19 billion/year), more land farmed, higher greenhouse gases

PURDUE UNIVERSITY | Agriculture News

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Study: Eliminating GMOs would take toll on environment, economies

February 29, 2016

WEST LAFAYETTE, Ind. - Higher food prices, a significant boost in greenhouse gas emissions due to land use change and major loss of forest and pasture land would be some results if genetically modified organisms in the United States were banned, according to a Purdue University study.

Wally Tyner, James and Lois Ackerman Professor of Agricultural Economics; Farzad Taheripour, a research associate professor of agricultural economics; and Harry Mahaffey, an agricultural economics graduate student, wanted to know the significance of crop yield loss if genetically modified crops were banned from U.S. farm fields, as well as how that decision would trickle down to other parts of the economy. They presented their findings at the International Consortium on Applied Bioeconomy Research in Ravello, Italy, last year. The findings of the study, funded by the California Grain & Feed Association, will be published in the journal AgBioForum this spring.

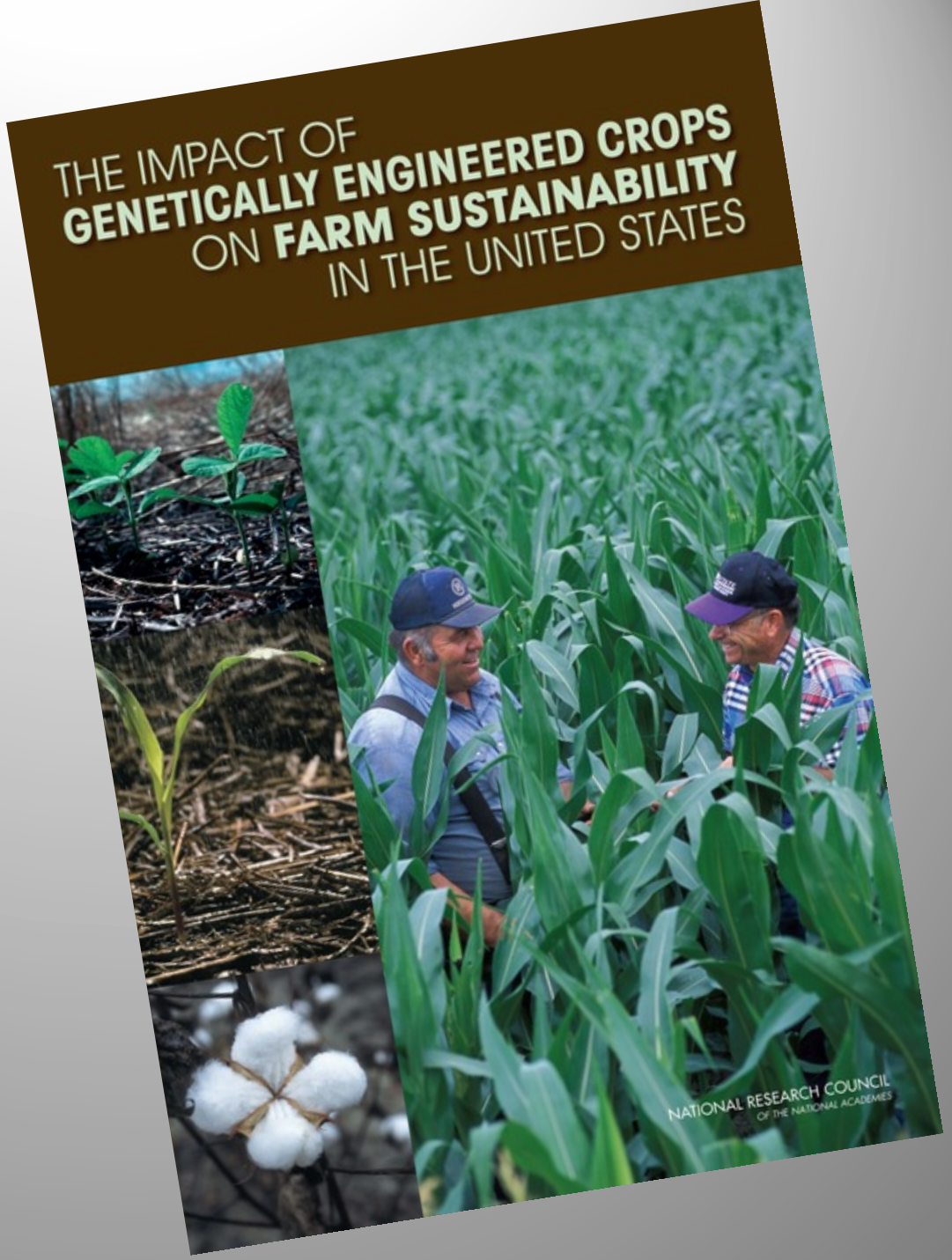
"This is not an argument to keep or lose GMOs," Tyner said. "It's just a simple question: What happens if they go away?"

The economists gathered data and found that 18 million farmers in 28 countries planted about 181 million hectares of GMO crops in 2014, with about 40 percent of that in the United States.

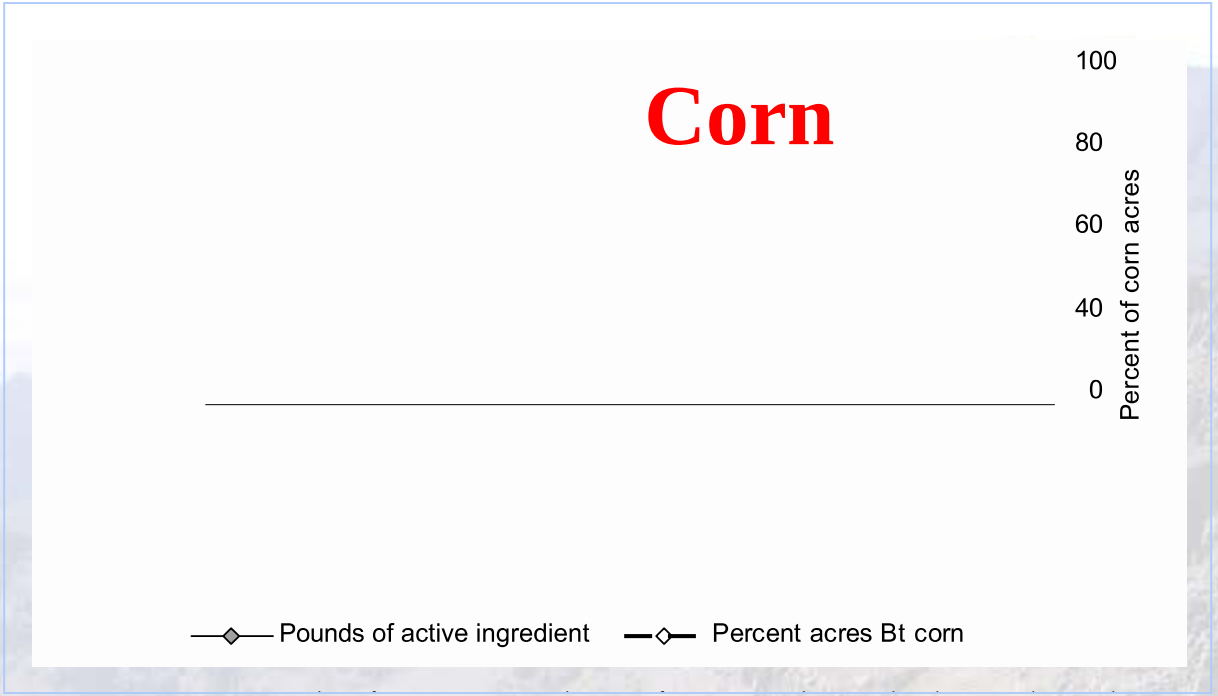
They fed that data into the Purdue-developed GTAPBIO model, which has been used to examine economic consequences of changes to agricultural, energy, trade and environmental policies.

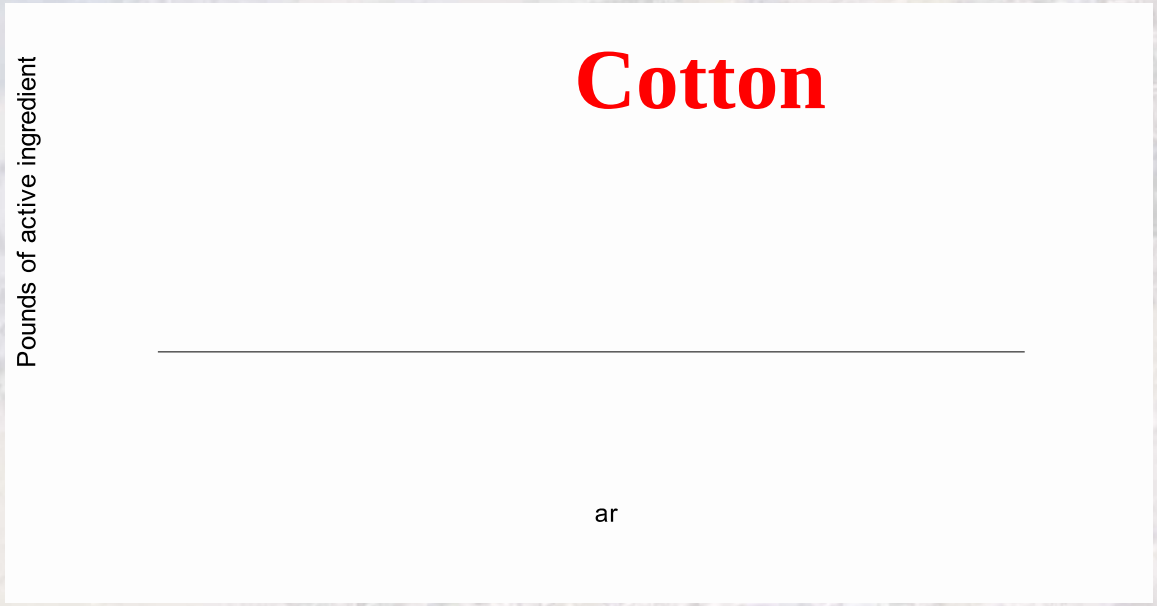
Many National Research Council reports on GMOs

Major pesticide reductions, conservation tillage expansion, need for more sustainable pest management



U.S. insecticide use per acre reduced due to Bt crops



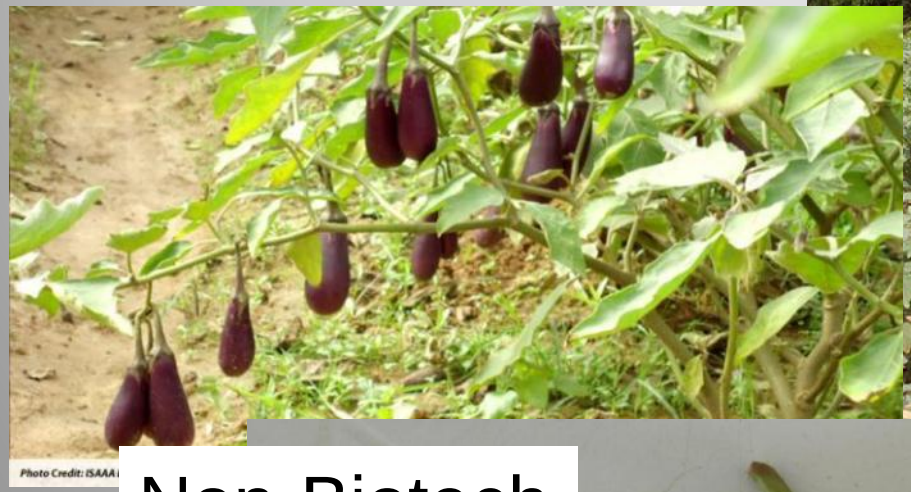


National Research Council, National Academy of Sciences 2010

Global “meta-analysis” with similar results: 2014

“147 original studies were included.”
“On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.”

A human face: Pesticide poisoning common in developing world – eggplant example (Bangladesh)



Non-Biotech

Biotech

http://www.isaaa.org/resources/publications/briefs/47/download/isaaa-brief-47-2014.pdf

Billions suffer from micronutrient deficiency

Widespread, impacts severe, and decades of supplements unable to overcome

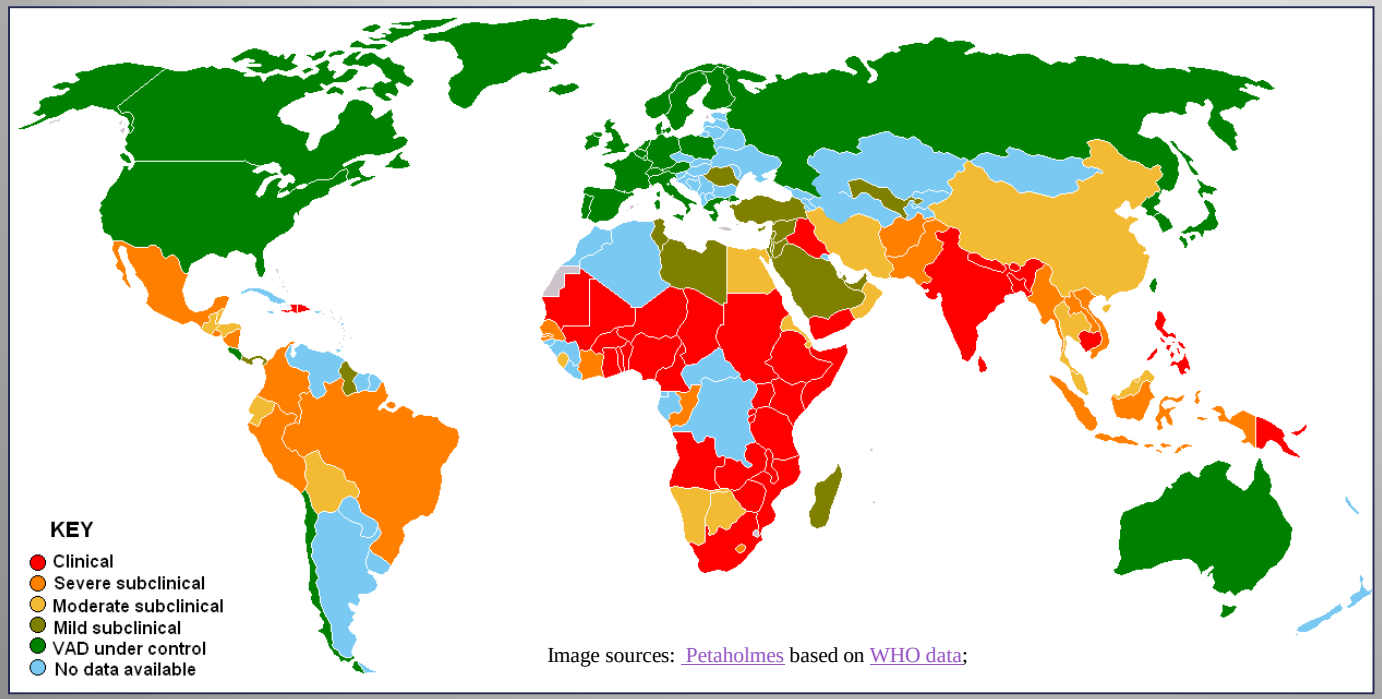
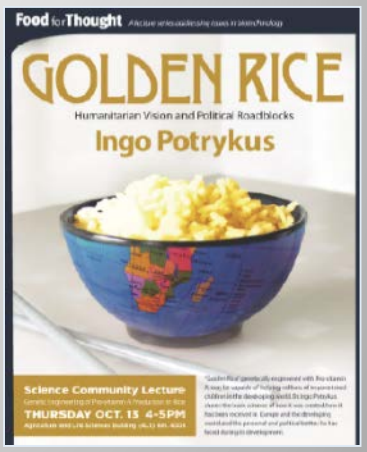


Image sources: Petaholmes based on WHO data;



Young women suffering blindness due to Vit A deficiency

Vitamin A deficiency affects <u>one-third of children</u> under the age of five around the world

Herbicide tolerant plants promote conservation tillage – With many environmental benefits thereof

Conservation Technology Information Center

- Lowers greenhouse gas emissions
- Improves soil organic matter
- Reduces erosion and fertilizer runoff into water

Global: In 2012 reduced CO2 emissions by ~27 billion kg, equivalent to ~13 million cars off the road
http://www.isaaa.org/resources/publications/briefs/46/topfacts/default.asp

GE offers new and improving options for tweaking native genes, and for using natural mechanisms to create highly safe pest-resistant crops

RNA interference (RNAi) for gene suppression

Nobel Prize for it's impact and mechanism

The Nobel Prize in Physiology or Medicine 2006

Andrew Z. Fire, Craig C. Mello

Share this: 28

The Nobel Prize in Physiology or Medicine 2006

Photo: L. Cicero

Andrew Z. Fire

Prize share: 1/2

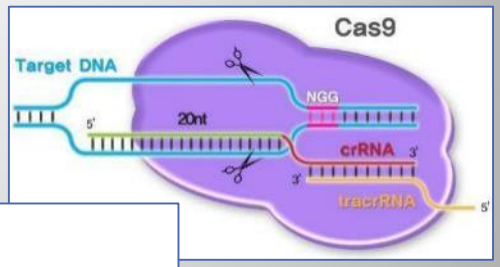
Photo: J. Mottern

Craig C. Mello

Prize share: 1/2

The Nobel Prize in Physiology or Medicine 2006 was awarded jointly to Andrew Z. Fire and Craig C. Mello *"for their discovery of RNA interference - gene silencing by double-stranded RNA"*

Coming: Gene editing technology for diverse traits



Science magazine names CRISPR 'Breakthrough of the Year'

By Robert Sanders | DECEMBER 18, 2015

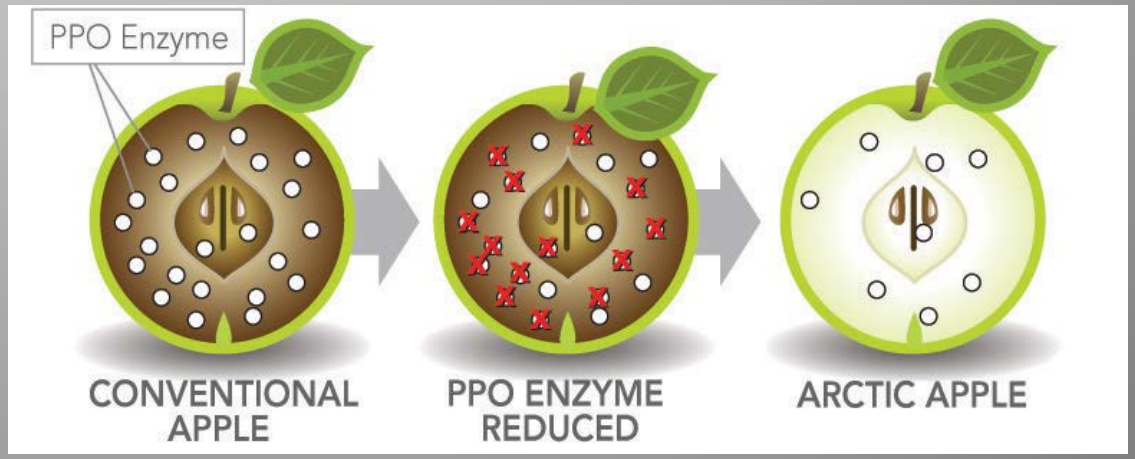
In its year-end issue, the journal *Science* chose the CRISPR genome-editing technology invented at UC Berkeley 2015's Breakthrough of the Year.

A runner-up in 2012 and 2013, the technology now revolutionizing genetic research and gene therapy "broke away from the pack, revealing its true power in a series of spectacular achievements," wrote *Science* correspondent John Travis in the Dec. 18 issue. These included "the creation of a long-sought 'gene drive' that

RNAi: Non-browning “Arctic Apple”

Reduced spoilage/waste, improved quality – USDA approved

Courtesy of Jennifer Armen, Okanagan Specialty Fruits, Canada



Non-browning “Arctic Apple”

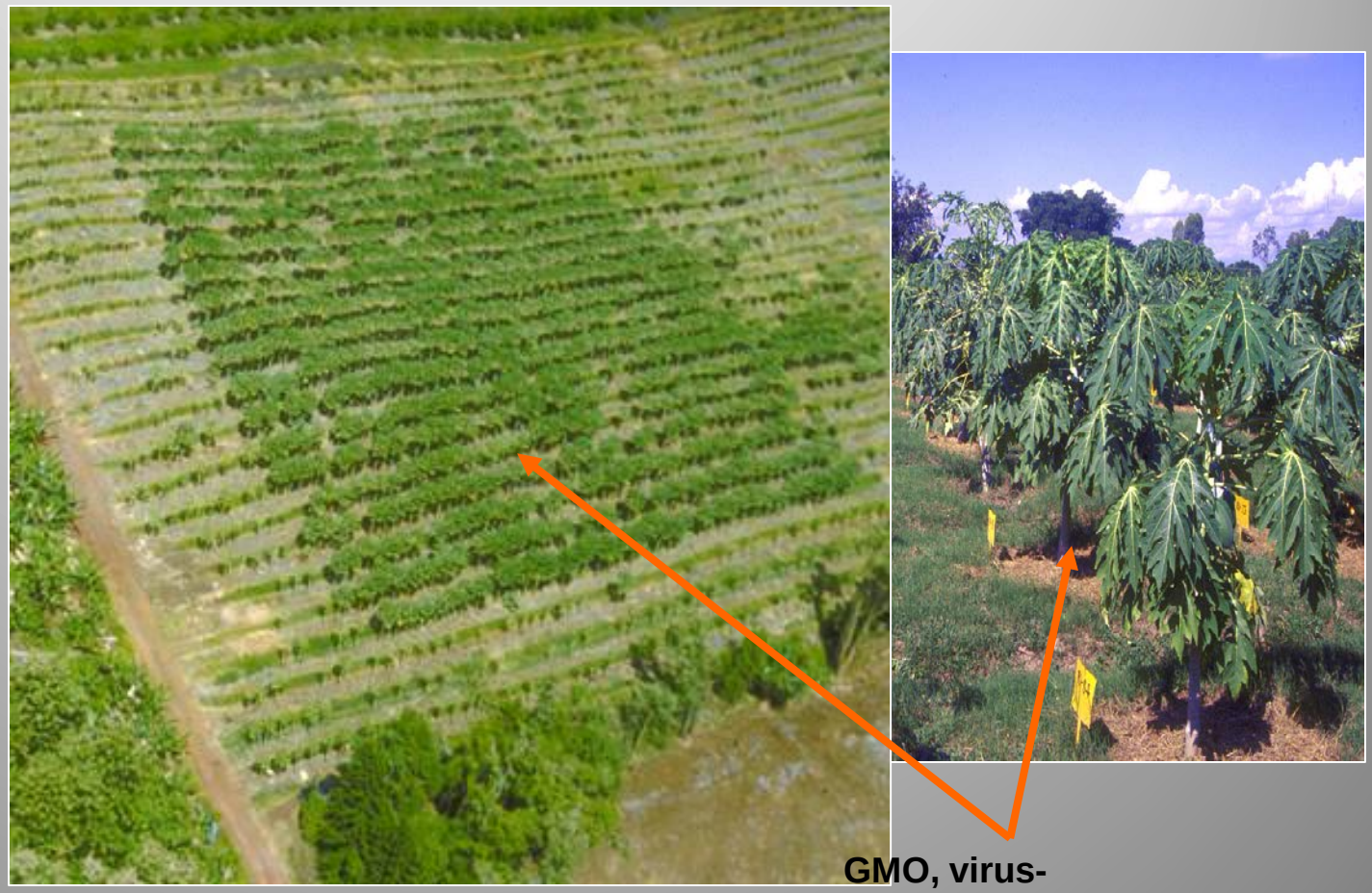
Time lapse video

They are good!

RNAi: Virus-resistant GM papaya

Saved the Hawaiian industry in the mid-1990s, ~80% of crop today

"RNAi immunization" via implanting a viral gene in the papaya genome



GMO, virus-resistant trees

Courtesy of Denis Gonsalves, formerly of Cornell University

Gene-edited hornless cattle – improved efficiency and animal welfare

Open Season Is Seen in Gene Editing of Animals

By AMY HARMON NOV. 26, 2015

A calf, left, approximately the same age as the [illegible] they do not grow horns, right. Jenn Ackerman fo[illegible]

The New York Times

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Poor regulation or management of established crops

- Large scale production field approved for herbicide resistant creeping bentgrass in Oregon – difficult to remove from environment
- Unsustainable management of Roundup resistant crops – Rapid weed evolution due to excessive use of Roundup
- Mixed record for insect resistant crops

Roundup-resistant bentgrass found along waterways, drainage ditches

Regulatory loopholes might allow more of this in the environment

Scotts' GM grass grows free from regulation

Scotts Miracle-Gro is developing a turf grass that has been genetically modified (GM) to grow shorter, thicker and darker green than its conventional counterparts. The enhanced grass from the Marysville, Ohio–based lawn and garden company is yet another novel plant to fall outside the purview of the US Department of Agriculture (USDA), according to documents released in December on the agency's "Regulated Letters of Inquiry" web page.

Scotts says the grass—a tall fescue variety—will require less particularly those who export to countries where GM plants are not permitted. And unlike for grasses that are subject to USDA's oversight, Scotts doesn't have to publicly disclose whether or not it is conducting field trials or the genes it is using to confer the traits—something that must be done for regulated GM plants before commercialization. Without knowing what the transgenic material is, "we don't even know how to test for it," says Carol Mallory-Smith, a weed scientist at Oregon State University. "It's a big discussion out here in seed country."

Scotts has said it will not grow its GM cultivars in Oregon, where much of the non-GM proprietary tall fescue seed is produced. The company also says it will insert into the trait construct of its GM grasses a genetic marker and can provide sequence information to interested parties, such as non-GM grass producers, weed scientists and governments, who want to identify the GM cultivars,

Poor weed management has led to rapid development of herbicide-resistant weeds

And motivated development of new kinds of herbicide tolerant crops

nature biotechnology

nature.com ▸ journal home ▸ archive ▸ issue ▸ news ▸ full text

NATURE BIOTECHNOLOGY | NEWS

Glyphosate resistance threatens Roundup hegemony

Emily Waltz

Nature Biotechnology **28**, 537–538 (2010) | doi:10.1038/nbt0610-537
Corrected online **13 October 2010**
Corrigendum (October, 2010)

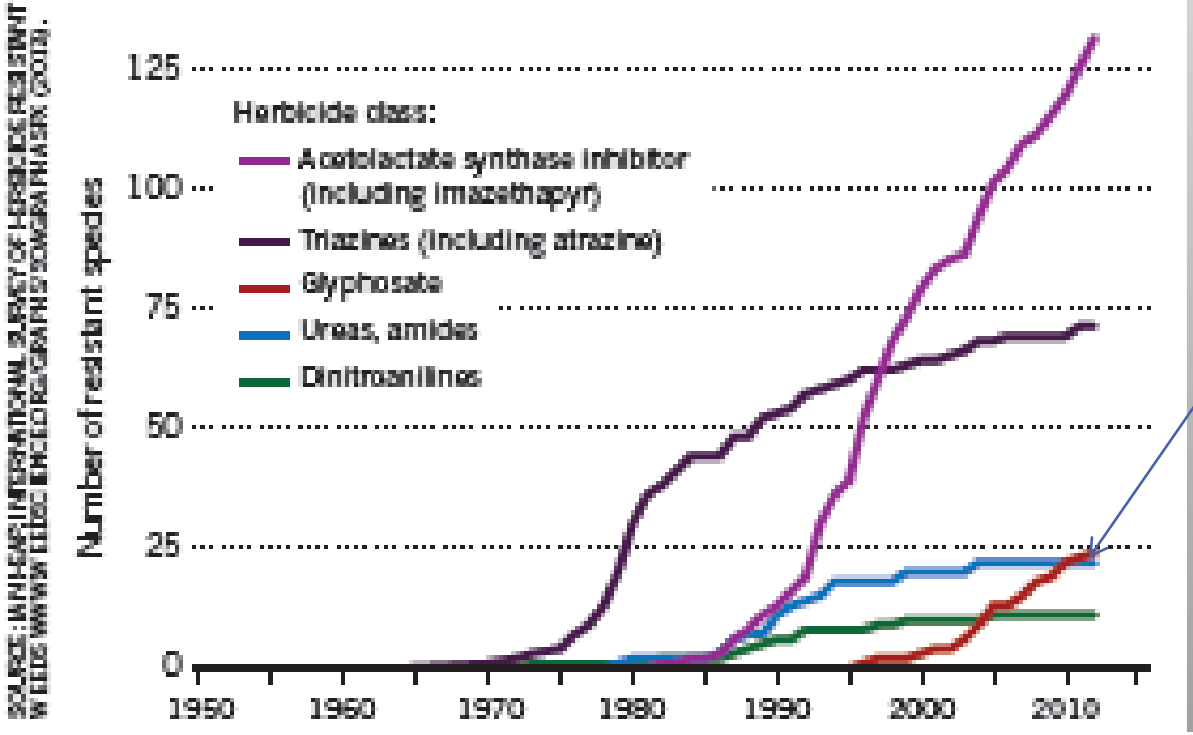
PDF | Citation | Reprints | Rights & permissions | Article metrics

Weeds are becoming increasingly resistant to glyphosate, a report from the US National Academy of Sciences (NAS) released in April has found. The driving force, according to the report, is farmers' dependence on the weed killer accompanied by the widespread adoption of genetically modified (GM) herbicide-tolerant crops. Seed makers are hoping to forestall the problem by developing GM crops with 'stacked' traits that tolerate multiple herbicides. But weed scientists warn that if farmers manage these new crops in the same way as they managed their glyphosate-tolerant predecessors, weeds will simply become resistant to the new technologies.

"The number of weed species evolving resistance to glyphosate

BILL BARKSDALE / AGSTOCKUSA /

Herbicide-resistant weeds are an old problem in agriculture, but exacerbated by GE herbicide tolerant crops



Accelerated by GE Roundup-tolerant crops

24 | NATURE | VOL 497 | 2 MAY 2013

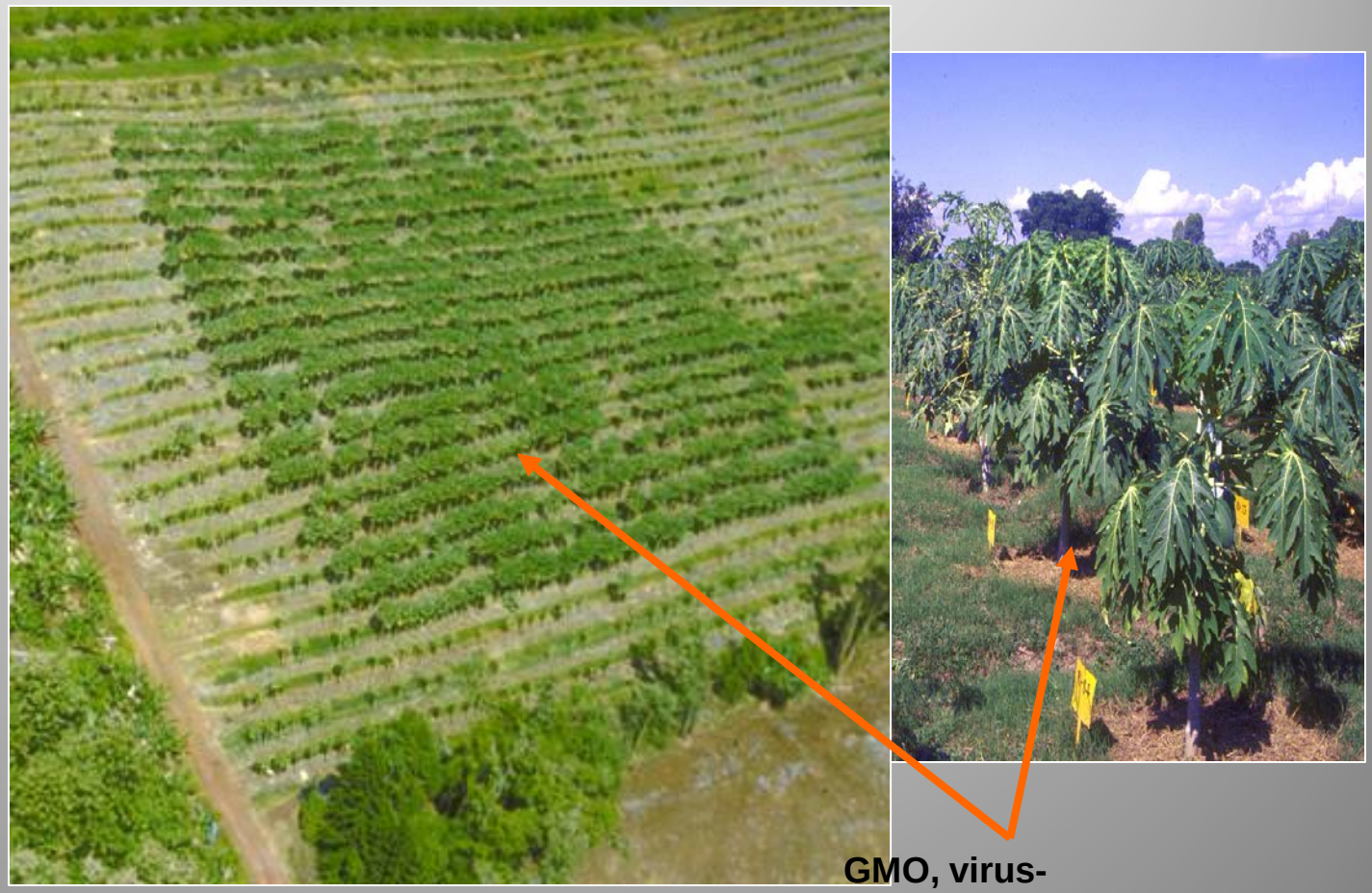
Difficulty in use of GE crops where valuable due to market and regulatory barriers

- EPA treatment of new forms of pest resistant crops as “pesticide producers” – very high costs of approval, difficult management
- Risks of low levels of gene dispersal even when environmental and health risks trivial – case of wheat in Oregon
- Proliferation of anti-GMO campaigns, GMO-free labels on many products, despite an absence of scientific support

Virus-resistant GM papaya

Saved the Hawaiian industry in the mid-1990s, ~80% of crop today

"RNAi immunization" via implanting a viral gene in the papaya genome



GMO, virus-resistant trees

Courtesy of Denis Gonsalves, formerly of Cornell University

Oregon GMO “wheat-gate” shows the risks from gene flow with GE crops, even research

OREGON'S ACCIDENTAL CROP

The discovery of GE wheat highlights regulatory failures

BRENT WOJAHN/THE OREGONIAN

y modified wheat found in an eastern Oregon field has
enetically engineered crops.

is, ensure that performance standards are met and trace
k the source of contamination that might occur as a result
GE experiments. This lack of basic information not only
ppers the government, but also threatens the agricultural

Op-Ed in Oregonian
June 16, 2013

An agreed safe, well studied, extremely rare GMO left over from earlier research nearly crippled Pacific Northwest trade in wheat in 2013, led to lawsuits

Due to fear of…

Low Level Presence (LLP)

…of unapproved genes in shipped wheat

Global admixture of GM and non-GM crops/food create immense coexistence, trade problems under current regulations

Many costly cases of trade disruption and lawsuits with corn, soy, and rice

UN News Centre

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Africa | Americas | Asia Pacific | Europe | Middle East

Steady increase in incidents of genetically modified crops found in traded food, UN agency reports

Source: UN Photo/Tobin Jones

Source: UN Photo/Tobin Jones

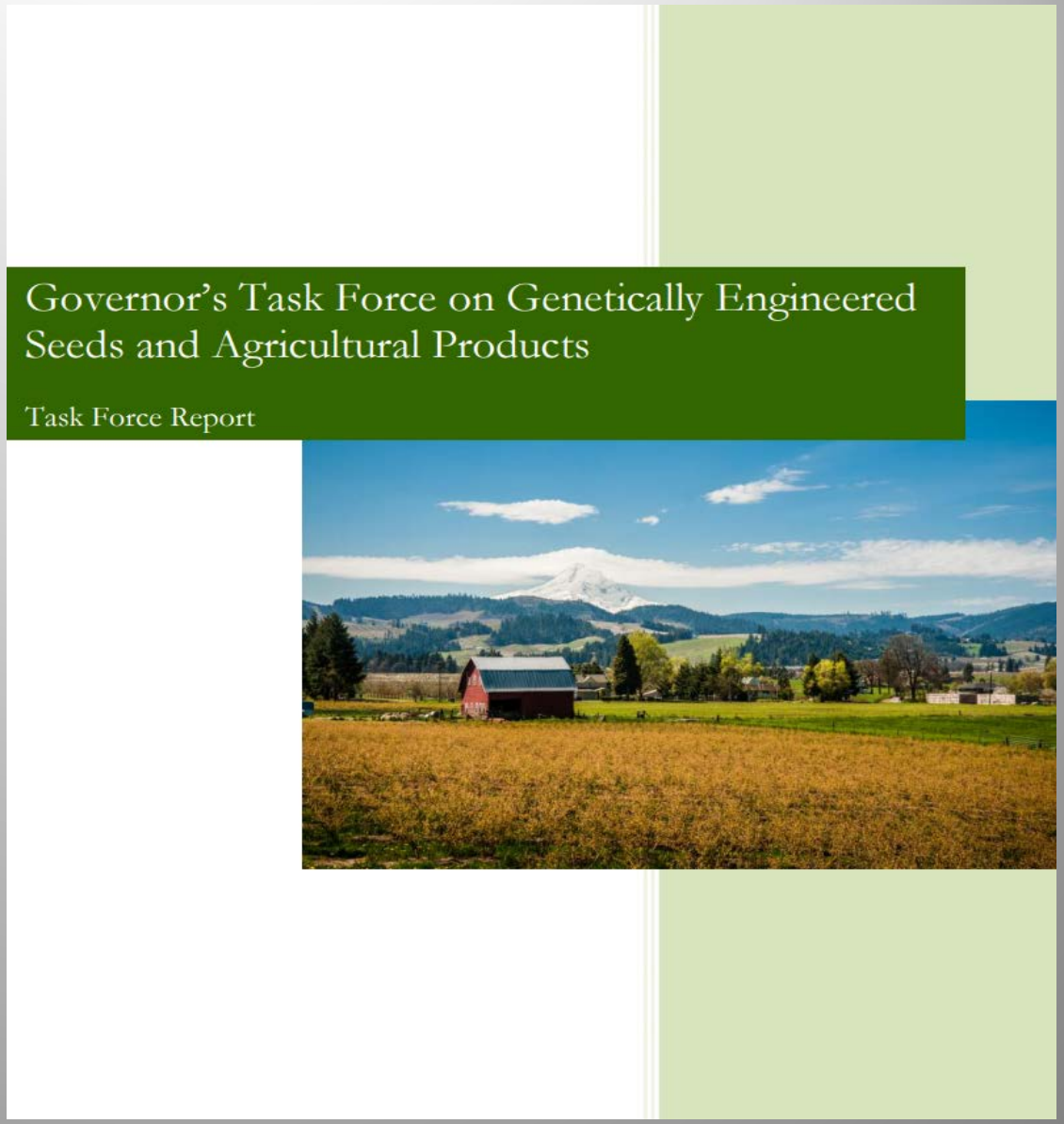
14 March 2014 – As a result of the increased production of genetically modified crops worldwide, the United Nations food agency warns in a ground-breaking survey that an increasing number of incidents of low levels of genetically modified organisms (GMOs) are being reported in traded food and feed.

18 Like

http://www.un.org/apps/news/story.asp?NewsID=47354&Cr=food+security&Cr1=#.UySzoPldVUV

Oregon with major coexistence struggles due to seed industry, much non-GMO production & many exports

2014 Task Force Report



GMO ban voted on in Benton County, Oregon last year – defeated, but with much public support for the ban

No easy answers to coexistence problems

Regulations, and ultimately markets, need to evolve to enable workable thresholds for genetic admixture…

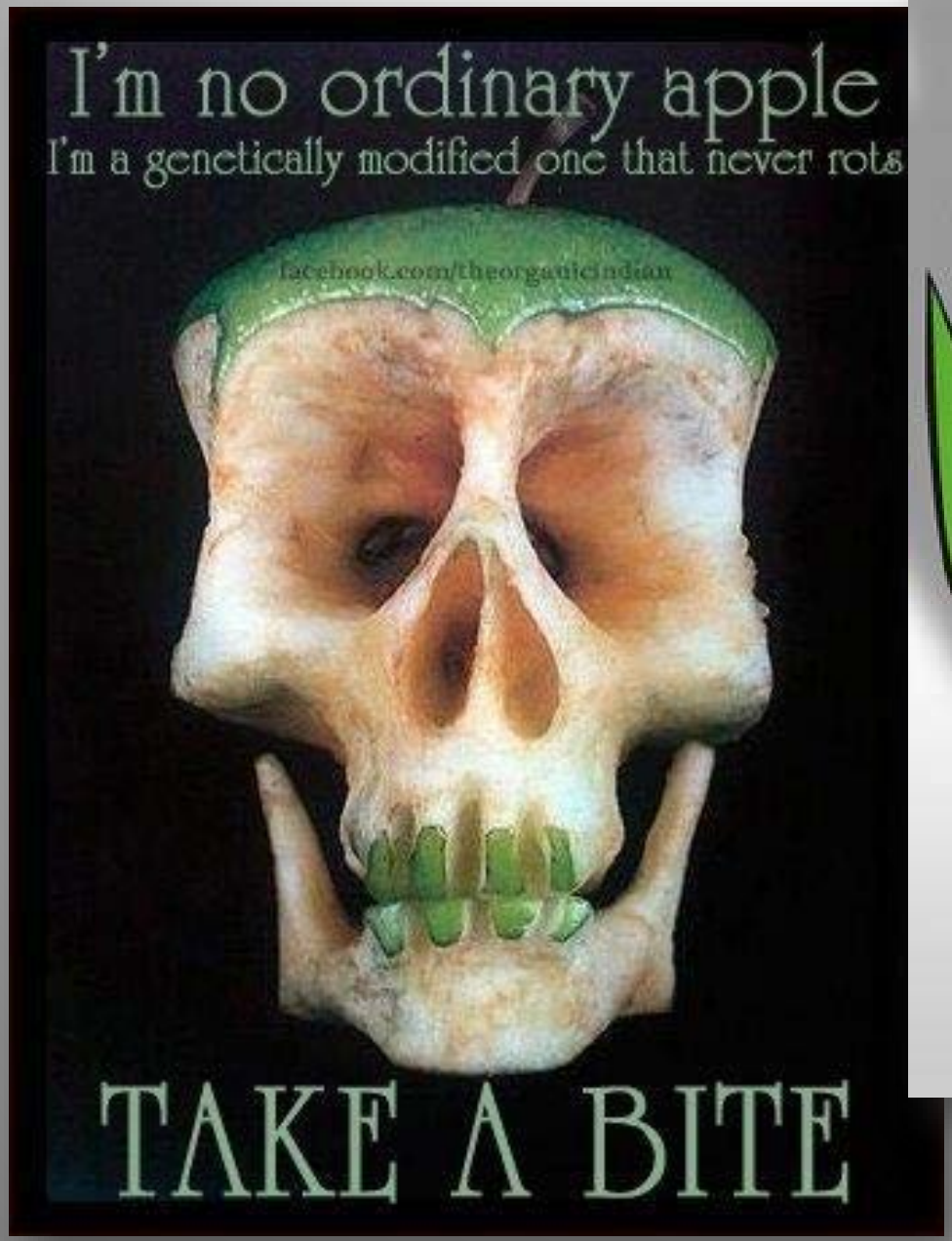
Agenda

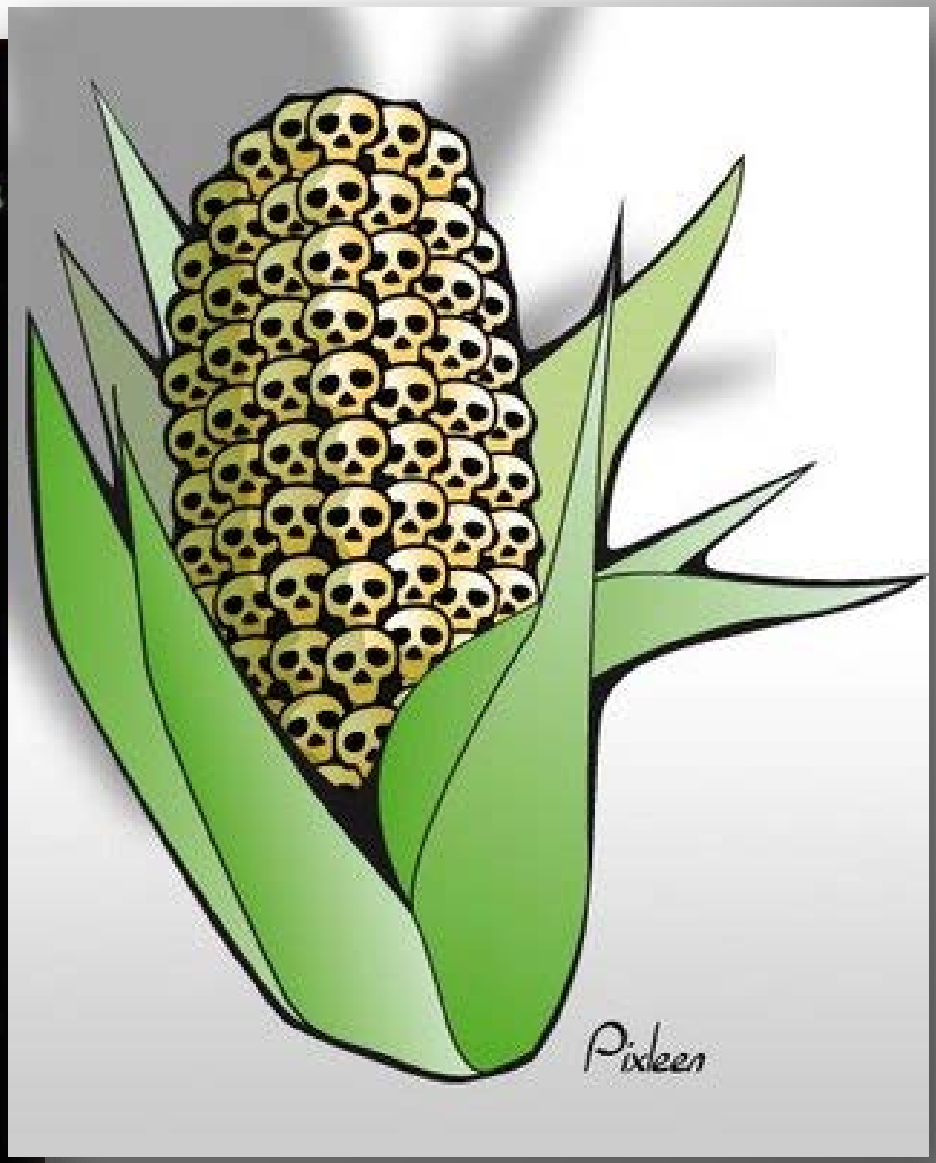
- Where do you stand?
  - Orientation to issues
- GMO literacy
  - Crop domestication/breeding
  - GE method
  - GE product examples
- Indications of wisdom
  - Regulations
  - Management of current GM crops
  - Obstruction by proliferation of myths, stigmatizing labels

There are numerous myths that are rampant and recycled in media

Vicious anti-GMO messages widespread

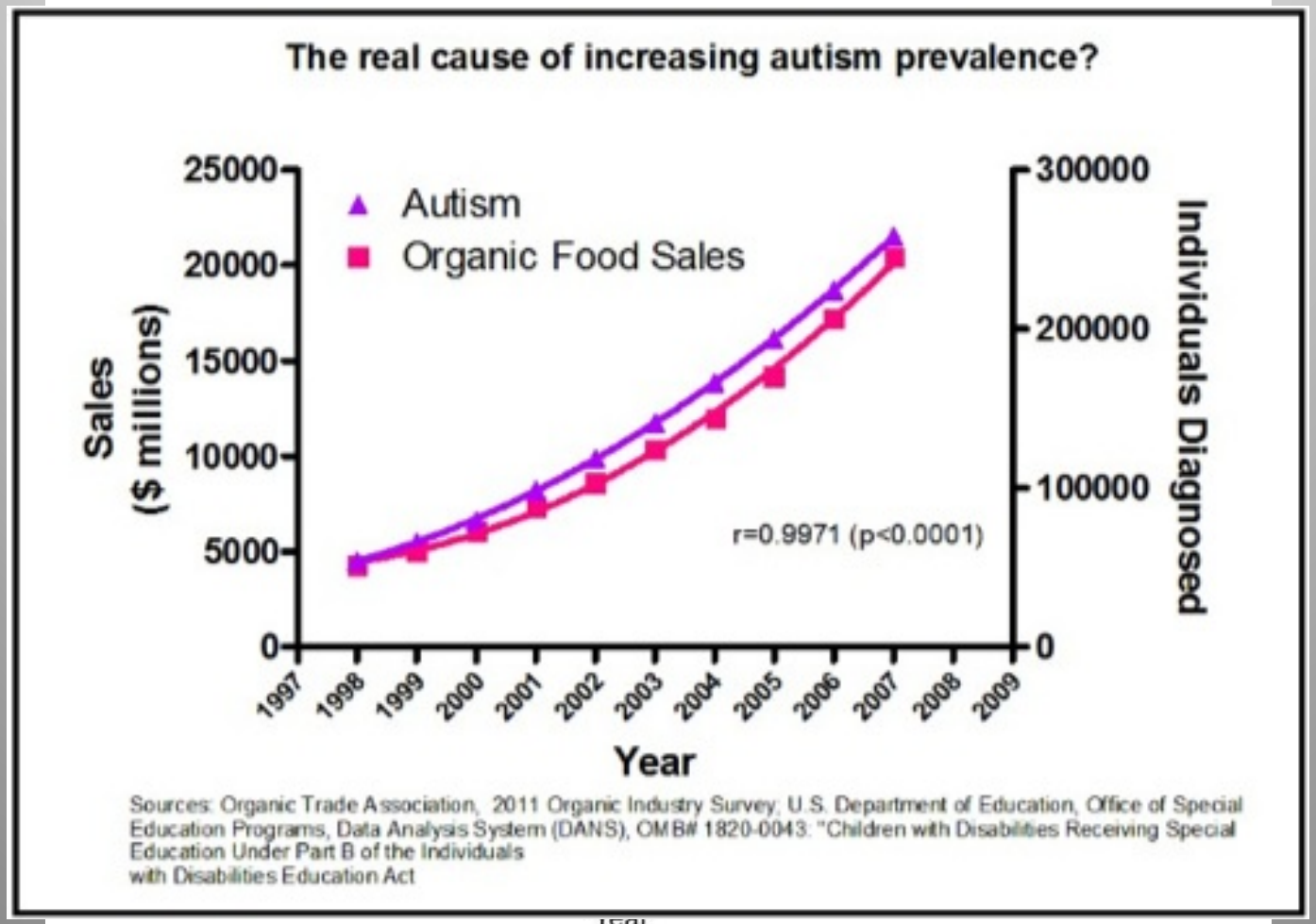
And many more





My colleague Steve Savage's favorite!

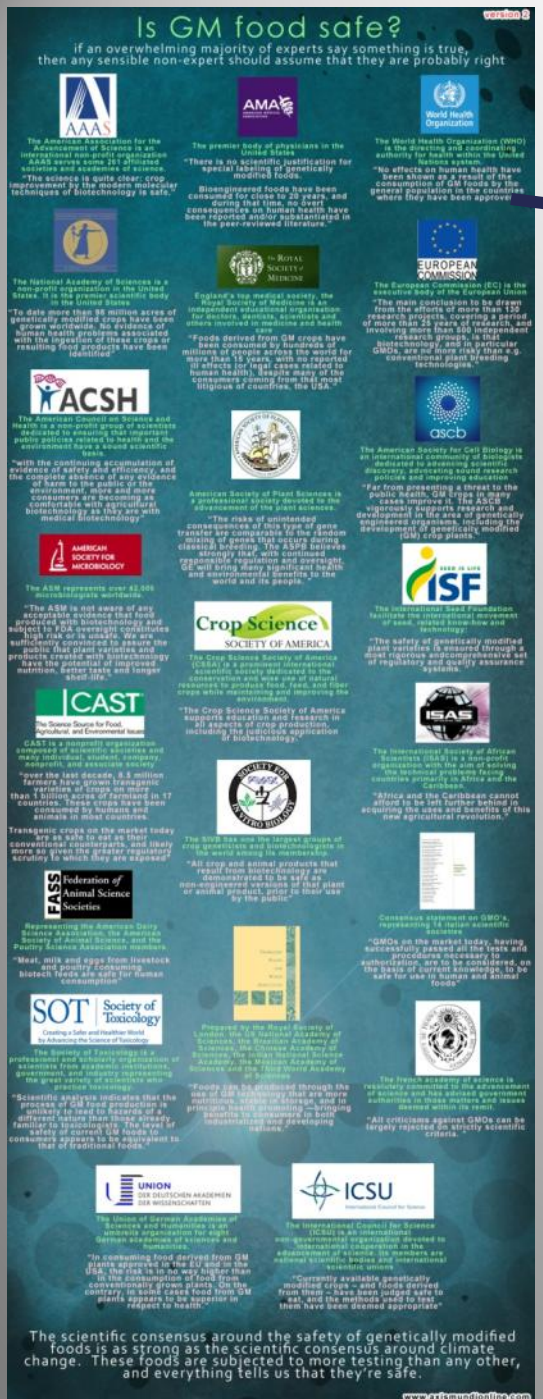
Much pseudo-science: “Half of all children will be Autistic by 2025 due to Roundup warns MIT scientist”



Myth: No food safety review of biotech crops

- Of 129 GE crops commercialized in the USA, 129 have had FDA review (2014)

- Global evaluations include: FDA, USDA, EPA, Health Canada, FSANZ, EFSA, Korea FDA, EFSA, Chinese Ministry of Agriculture, Japan Food Safety Commission



http://www.axismundionline.com/blog/the-new-is-gm-food-safe-meme/

Safety of foods supported by many dozens of international science organizations

Myth: Big Ag controls the media and public debate about GMOs

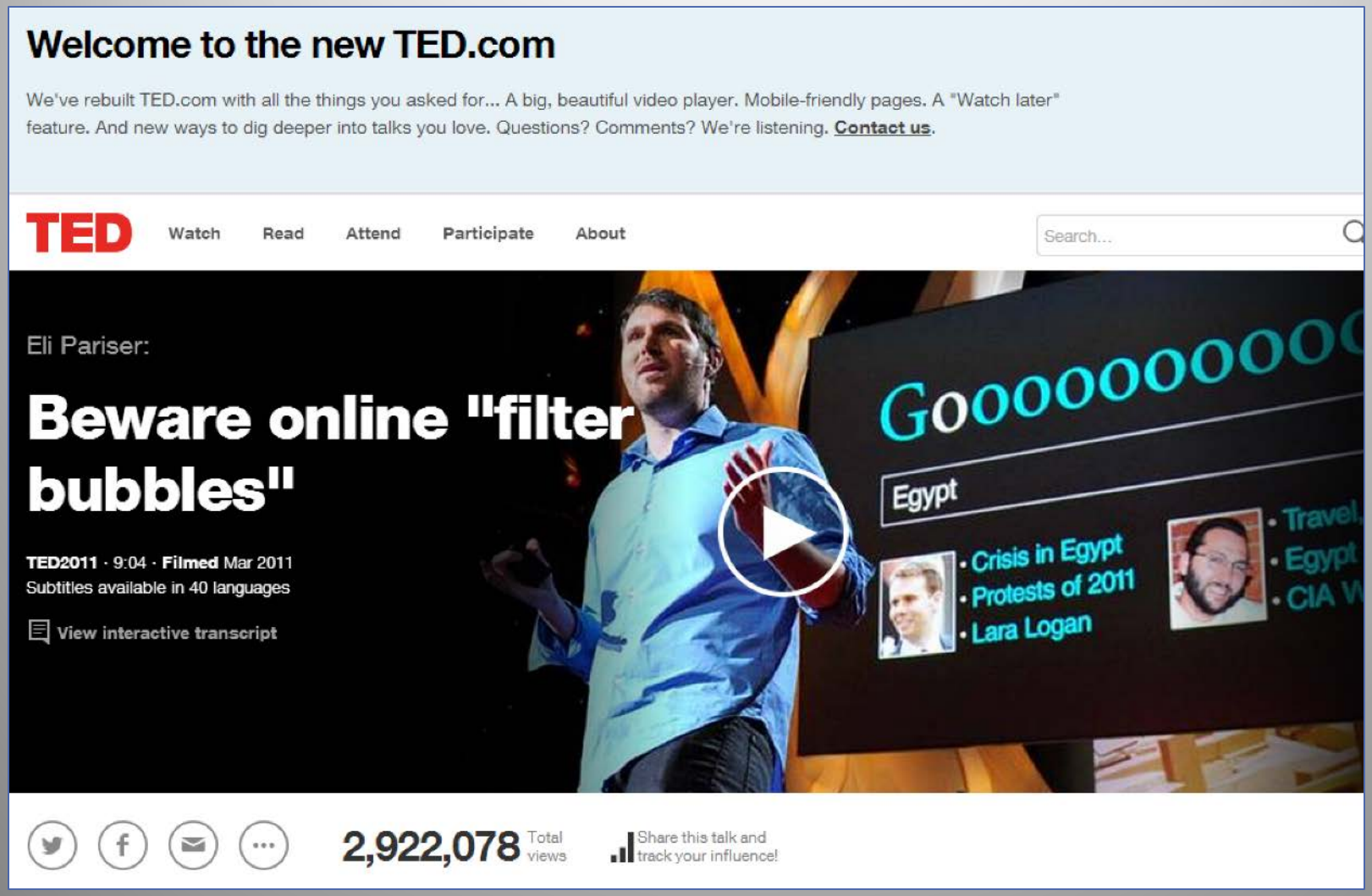
Not any more, big money also flows to demonize GMOs and associated ag/food

- Agbiotech Info Net
- Agribusiness Examiner
- ACGA
- American Pasturage
- APHA
- Animal Protection Institute
- Consumers Union
- Crop Choice
- David Suzuki Foundation
- Dawn Watch
- Deep Ecology
- Eco-Trust
- Economic Democracy
- Earth Spirit
- Earth First
- Environmental Defense
- Environmental Media Services
- FAIR
- Family Farm Defenders
- Farm Animal Reform Movement
- Farm Aid
- Farm Sanctuary
- Friends of the Earth
- GRACE
- Government Accountability Project
- Nishoren
- No Spray coalition
- NWARN
- Organic Consumers Association
- PANNA
- PETA
- PCRM
- PIRG
- Public Citizen
- Purdey Fund
- Sierra Club
- SEAC
- Water Keeper Alliance

More than 500 activist organizations in North America are spending in excess of $2 billion annually engaging in food-related campaigns targeting biotech and many other elements

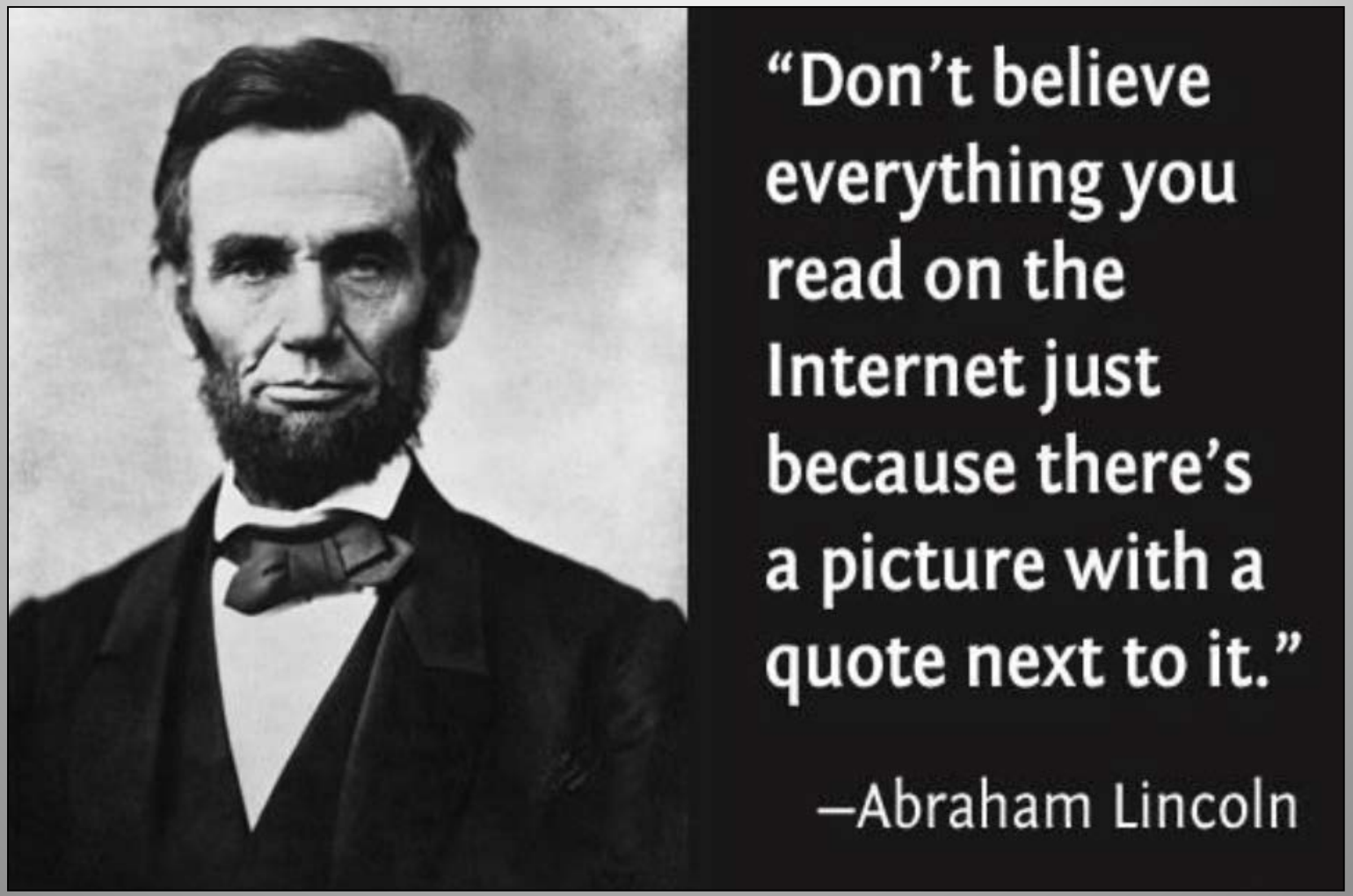
Jay Byrne, 2012, V-fluence

Pervasive online filters of information entrench, further polarize



https://www.ted.com/talks/eli_pariser_beware_online_filter_bubbles

Abe Lincoln warned us, but….



http://weknowmemes.com/2012/07/dont-believe-everything-you-read-on-the-internet

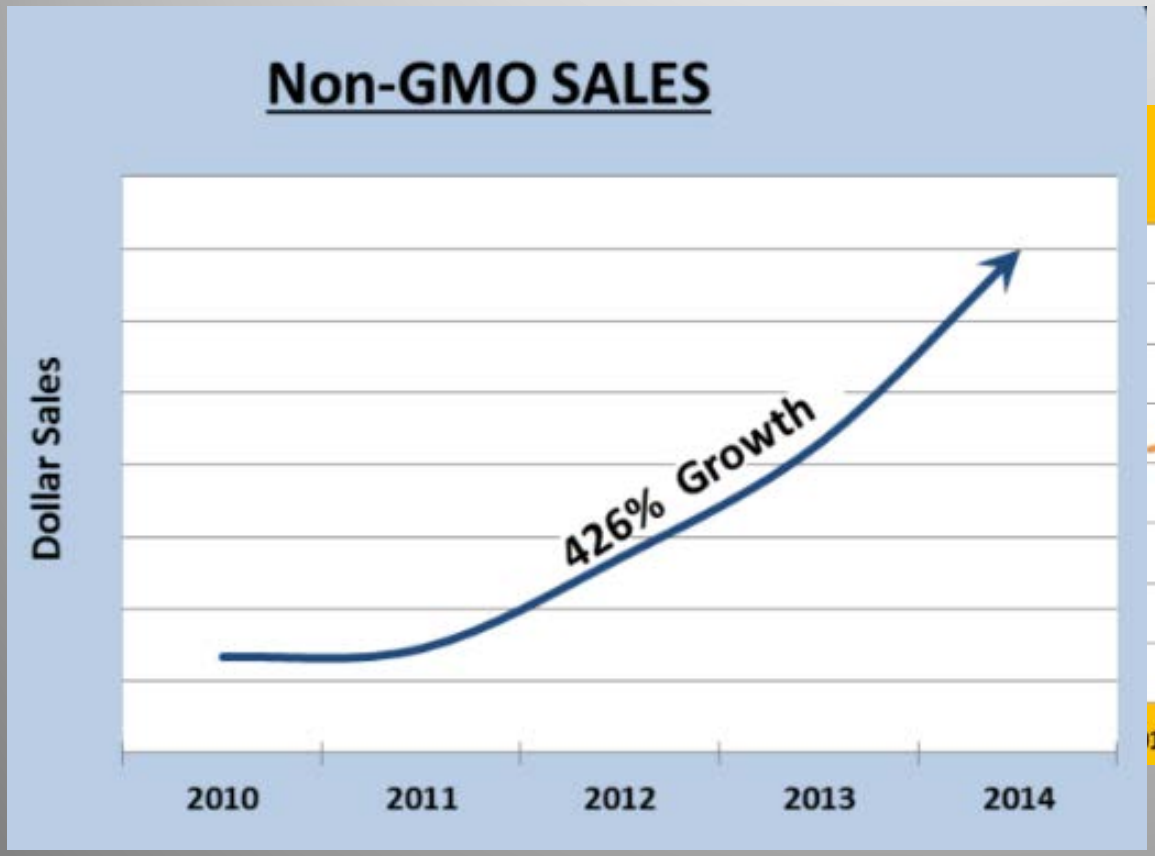
GMO-free identification common in the marketplace

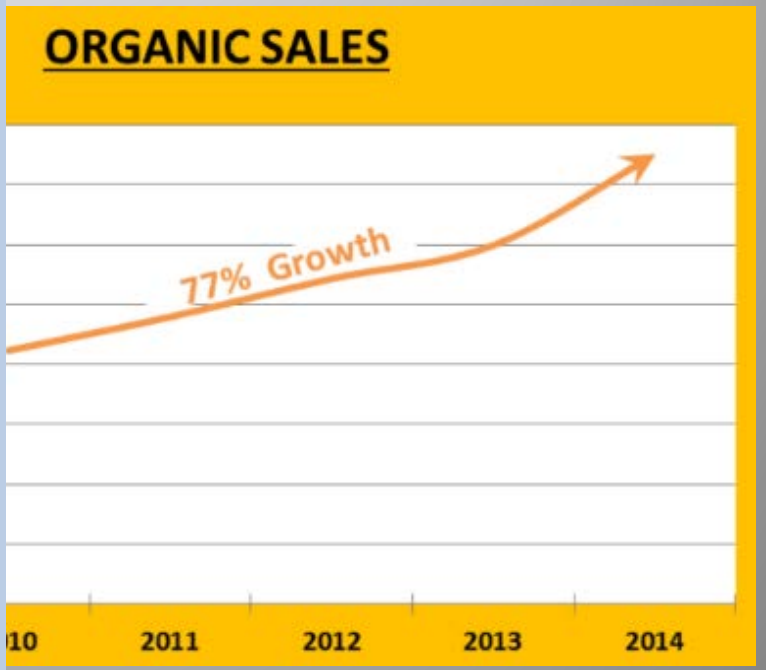
Meteoric rise of no-GMO labels

- GMO-free claims jumped 237% in new products 2012 to 2013

Organic and Non GMO Market Growth 2015

Errol Schweizer
Executive Global Grocery Coordinator
Whole Foods Market



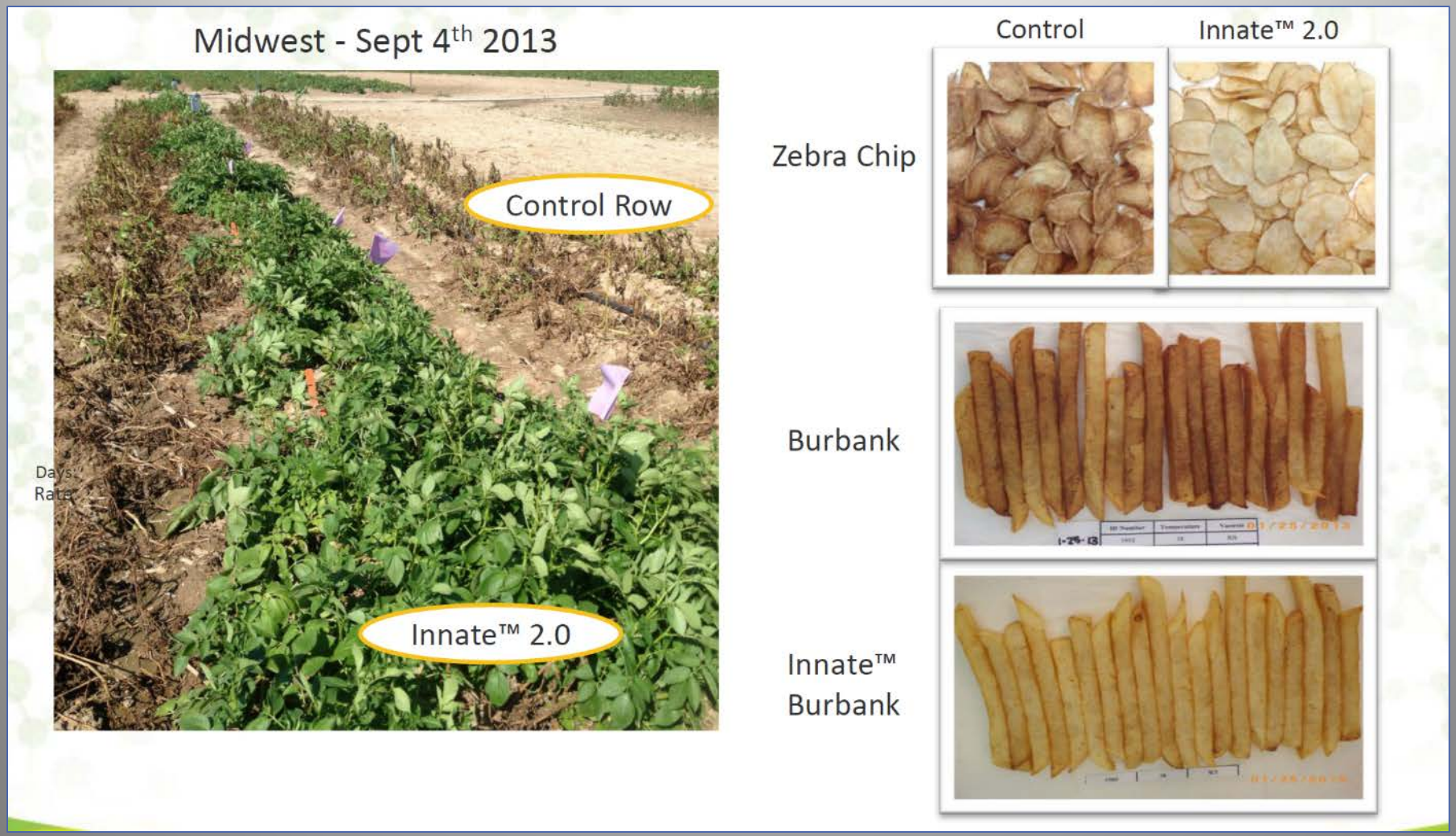


https://www.aphis.usda.gov/stakeholders/downloads/2015/coexistence/Errol-Schweizer.pdf

Many companies have avoided GMOs due to brand risk from activists/consumers

No-GMO labels on potatoes, in contrast to expected benefits of new GMO products

“Innate 2.0” potato – late blight resistant, and reduced sprouting and browning (↓ waste, ↑ safety, ↓ pesticide, ↑ yield)



Potential Innate Potato benefits

- **If all USA potatoes had it's improved traits, each year….**
- Waste reduced by 5 billion pounds
- CO_2 emissions reduced by 734 million pounds
- Water use reduced by 84 billion gallons
- 2.5 million fewer pesticide acre-applications
- Marketable yields increase ~ 20%
- Growers save $240 million in production costs

Am. J. Potato Res.
DOI 10.1007/s12230-015-9485-1

INVITED REVIEW

Biotech Potatoes in the 21st Century: 20 Years Since the First Biotech Potato

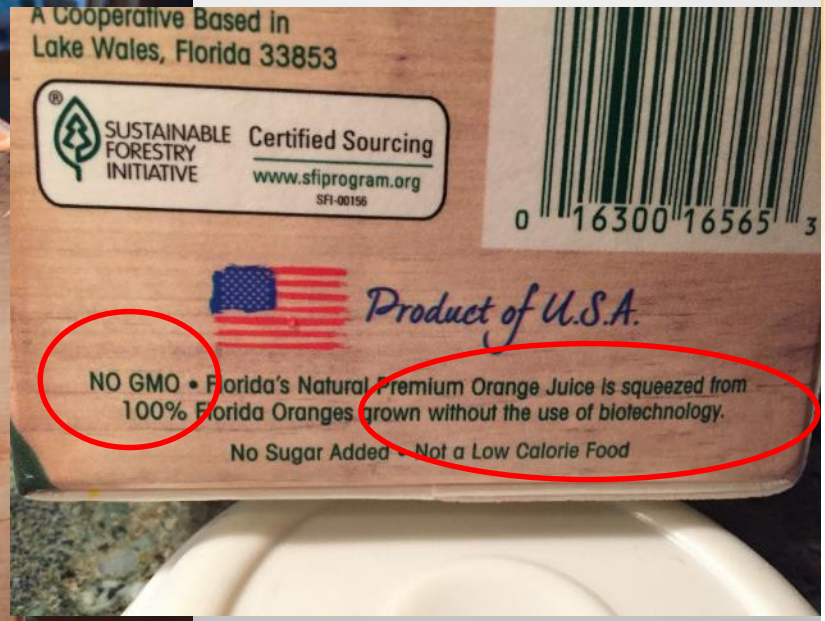
Dennis Halterman[1] · Joe Guenthner[2] · Susan Collinge[3] · Nathaniel Butler[4] · David Douches[4]

Abstract Potato is the world's most important vegetable crop, with nearly 400 million tons produced worldwide every year, lending to stability in food supply and socioeconomic impact. In general, potato is an intensively managed crop, requiring irrigation, fertilization, and frequent pesticide applications in order to obtain the highest yields possible. Important traits are

and the potential effects that biotech potato could have on the industry.

Resumen La papa es el cultivo hortícola más importante en el mundo, con cerca de 400 millones de toneladas producidas a nivel mundial anualmente, acreditando la estabilidad en el

No-GMO claims on orange juice



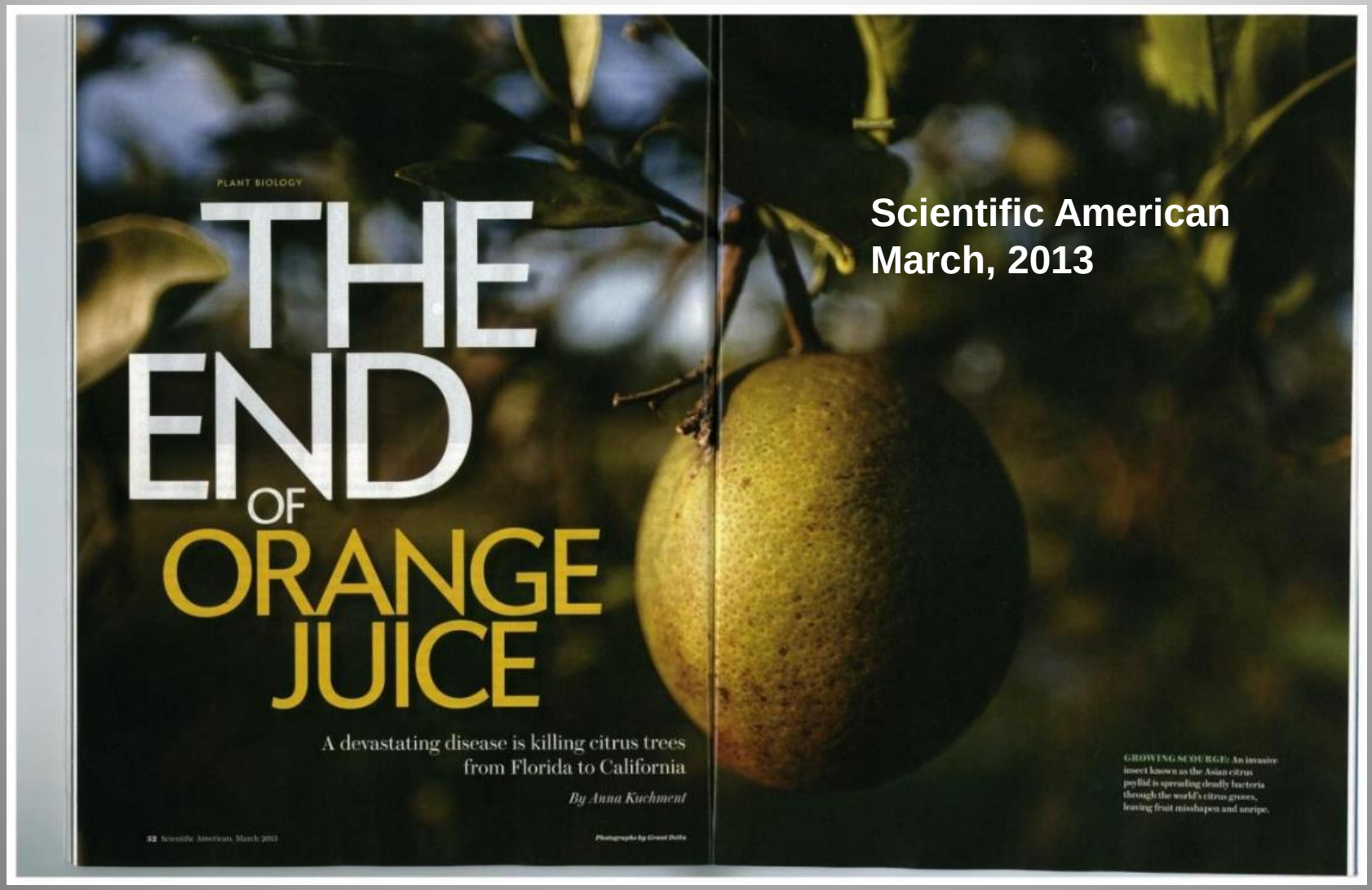
BUSINESS DAY

Some Tropicana and Other PepsiCo Products to Carry Non-GMO Project Seal

The New York Times

By STEPHANIE STROM DEC. 10, 2015

In spite of devastating ‘citrus greening’ that is threatening the entire industry



Defensin-like proteins from spinach for citrus greening disease resistance

Courtesy of Eric Mirkov, Texas A & M

Fast growing, sustainable GE salmon approved for contained use after nearly 20 years of regulatory delay

BUSINESS DAY

Genetically Engineered Salmon Approved for Consumption

By ANDREW POLLACK NOV. 19, 2015

20% improvement in FCR (feed

conversion ratio)

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Aquaculture 406–407 (2013) 141–152

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Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Effects of combined 'all-fish' growth hormone transgenics and triploidy on growth and nutrient utilization of Atlantic salmon (*Salmo salar* L.) fed a practical grower diet of known composition

S.M. Tibbetts [a], C.L. Wall [b], V. Barbosa-Solomieu [c,1], M.D. Bryenton [b], D.A. Plouffe [b], J.T. Buchanan [d], S.P. Lall [a,*]

[a] National Research Council of Canada, Aquatic and Crop Resource Development, 1411 Oxford Street, Halifax, Nova Scotia B3H 3Z1, Canada
[b] Center for Aquaculture Technologies Canada, 0718 Bay Fortune, R.R. No. 4, Souris, Prince Edward Island C0A 2B0, Canada
[c] AquaBounty Canada, 0718 Bay Fortune, R.R. No. 4, Souris, Prince Edward Island C0A 2B0, Canada
[d] Center for Aquaculture Technologies, 8395 Camino Santa Fe Street East, San Diego, CA 92121, United States

The New York Times

Use of GE salmon delayed indefinitely over labeling law inserted into funding bill

The Washington Post

To Your Health

FDA must develop plan to label genetically engineered salmon, Congress says

By Brady Dennis December 17, 2015 Follow @brady_dennis

A genetically engineered AquaBounty salmon, recently approved by the FDA, can grow twice as fast as its natural counterpart. (AP Photo/AquaBounty Technologies)

One more vote:

With respect to GE crops ….

A. They should be banned
B. Regulations need to be stricter
C. Regulations need to, selectively, be more lax
D. Misleading labels are a major problem for consumers
E. B, C and D are true