

Are we using GMOs wisely?

Steve Strauss

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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:

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www.pewresearch.org

JANUARY 28, 2015

PUBLIC AND SCIENTISTS' VIEWS ON SCIENCE AND SOCIETY

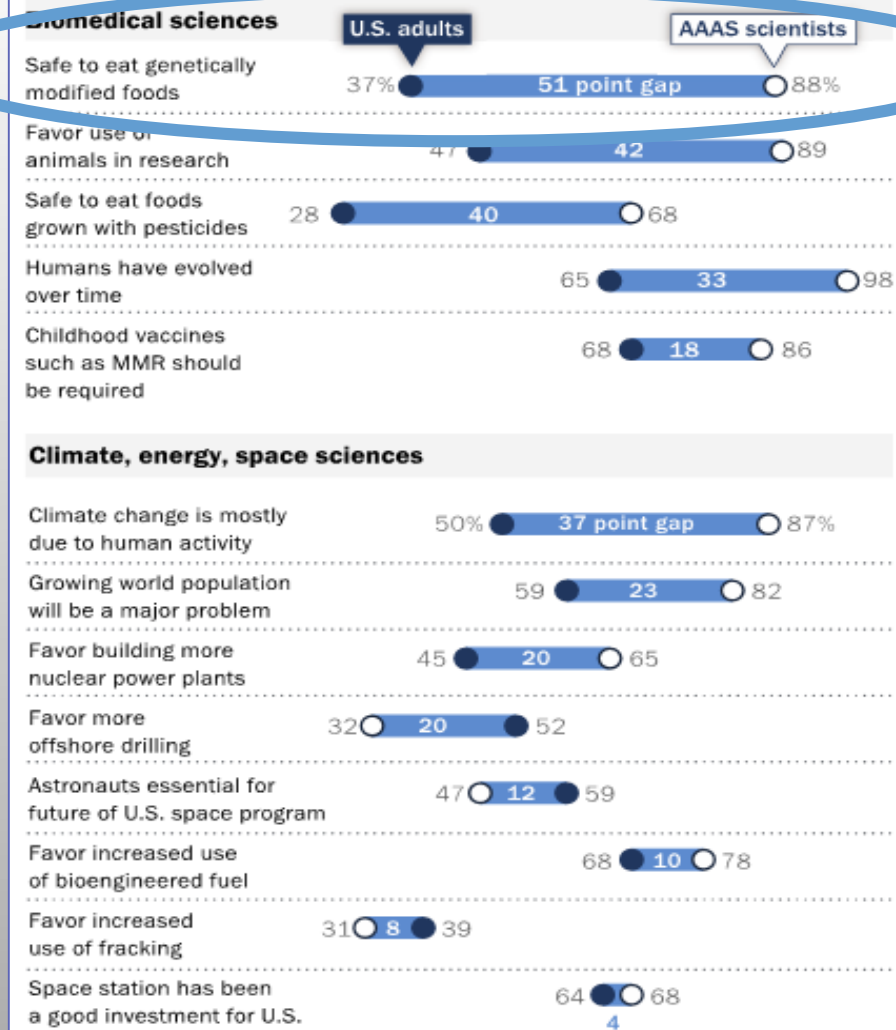
88% of AAAS scientists say genetically modified foods are safe to eat; only 37% of the public agrees



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

Opinion Differences Between Public and Scientists

% of U.S. adults and AAAS scientists saying each of the following



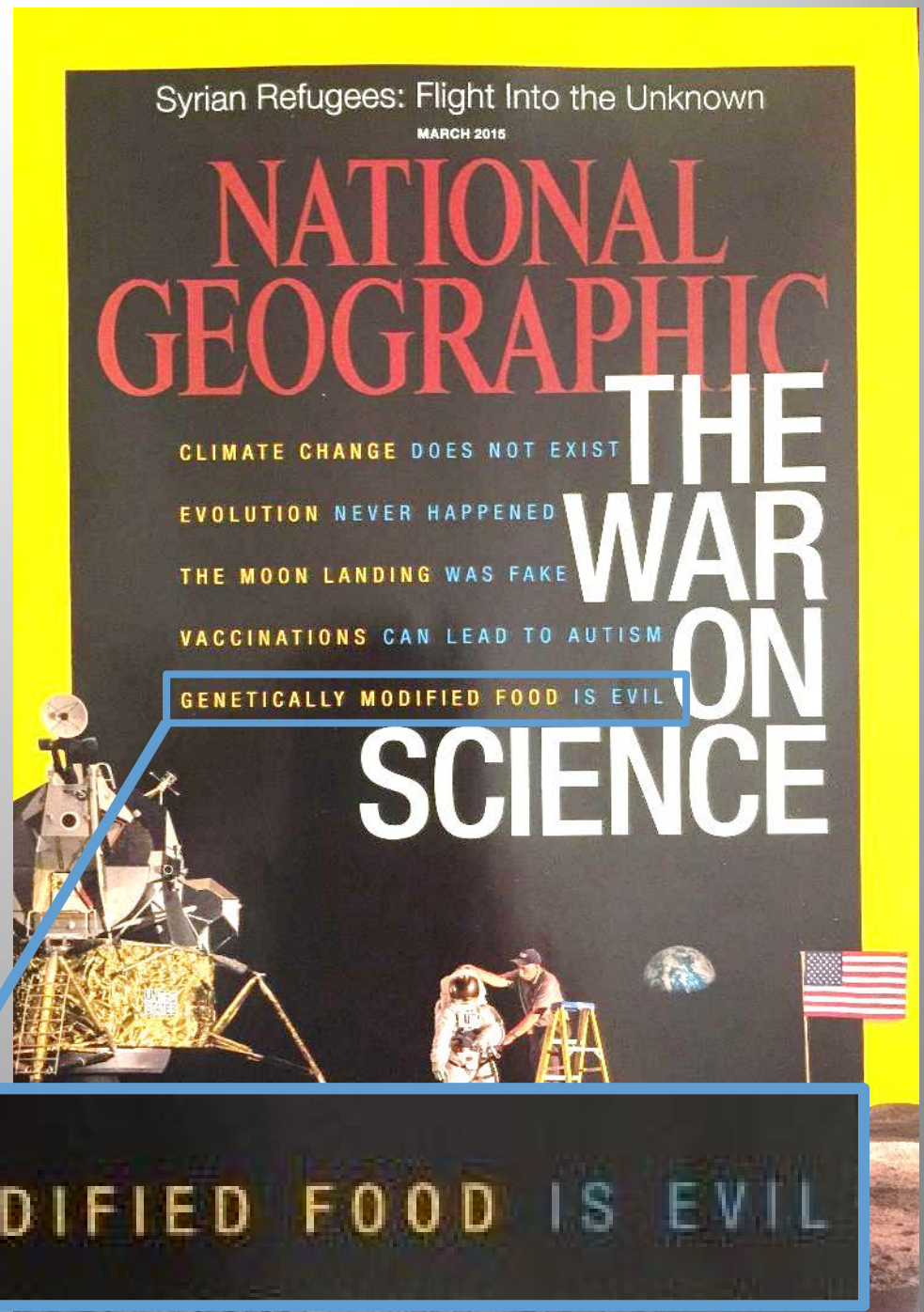
Survey of U.S. adults August 15-25, 2014. AAAS scientists survey Sept. 11-Oct. 13, 2014. Other responses and those saying don't know or giving no answer are not shown.

PEW RESEARCH CENTER

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 food supply. The occasional claim that GM foods are harmful to animals, ranging from digestive problems to sterility, tumor growth, and death. Although such claims are often sensationalized and receive a

Approved by the AAAS Board of Directors on 20 October 2012



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)



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

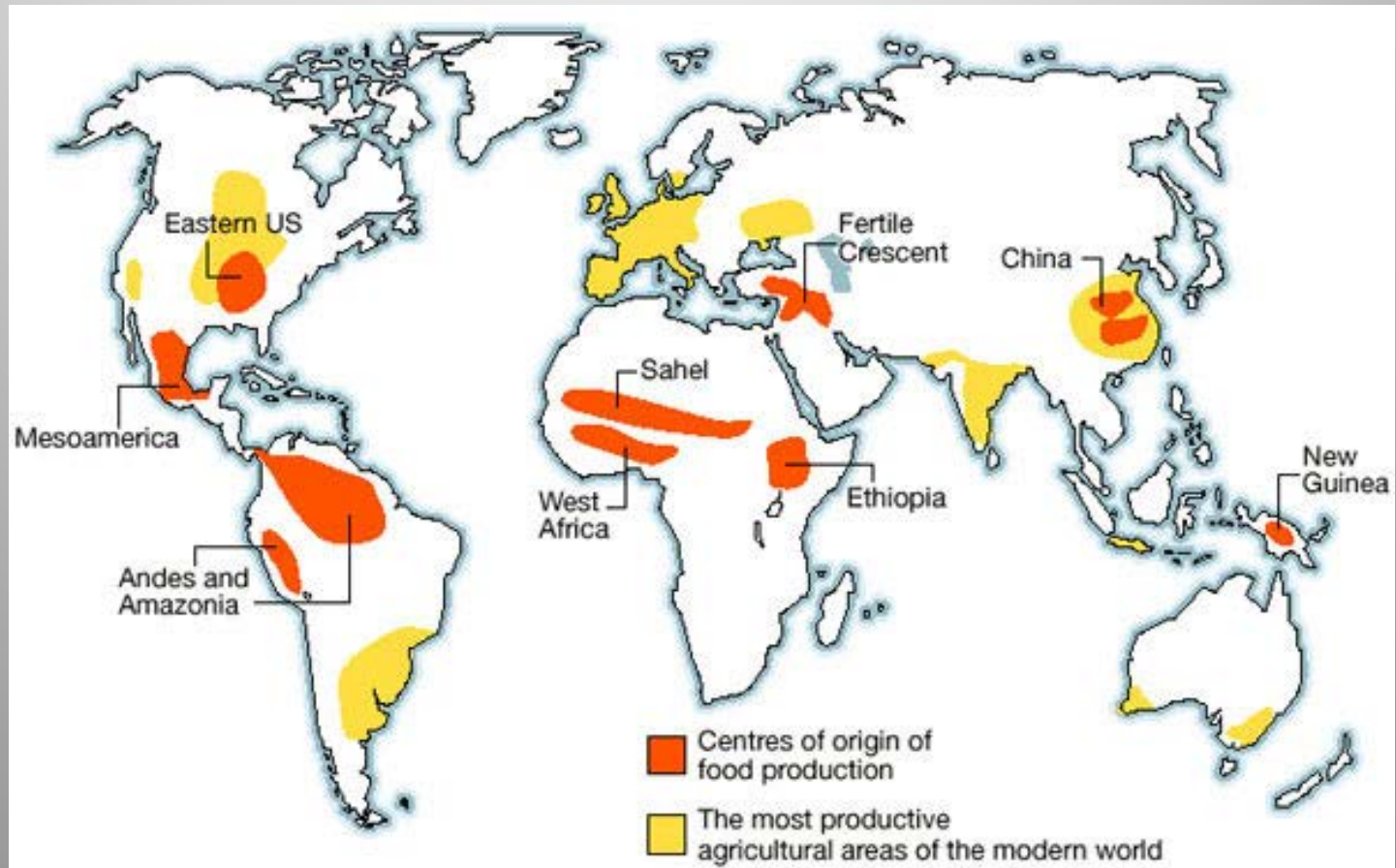
Why do GMOs matter to you?

- 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

Agenda

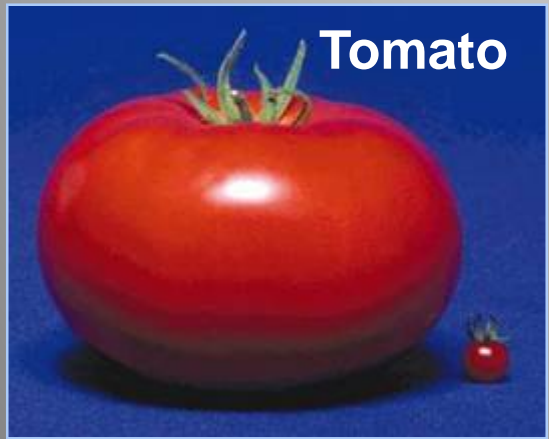
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Crops were domesticated in parallel in several regions of the globe – then moved and further bred all over the world



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A few of the major modifications made



Wild
cabbage



Kohlrabi
Germany, 100 AD

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

Ornamental kale
Late 1900's



Kale, 500 BC



Cauliflower
1400's

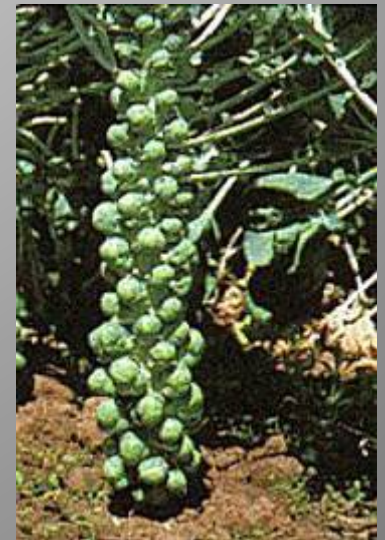


Broccoli
Italy, 1500's



Cabbage, 100 AD

Brussel sprouts
Belgium, 1700's



Many plant varieties derived from induced mutations



Calrose 76 semi-dwarf rice

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



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





Home / All Products / New Products / Plant-Indigo Rose Tomato

- Growing Guides
- Dealer Locator
- Territorial's Tomato Taste-Off

GET A FREE CATALOG 

THE DRUNKEN BOTANIST PLANT COLLECTION 

GIFT CERTIFICATES 

VISIT THE STORE 

NEWSLETTER SIGNUP






Plant-Indigo Rose Tomato


80 days. Unlike any tomato that we have seen! Indigo Rose is the first high-anthocyanin tomato commercially available anywhere in the world. The high amount of anthocyanin (a naturally occurring pigment that has been shown to fight disease in humans) creates quite a vibrant indigo, almost blue skin on the 2 inch, round fruit. The purple coloring occurs on the portion of the fruit that is exposed to light, while the shaded portion starts out green and turns deep red when mature. Inside, the flesh reveals the same rosey tone with a superbly balanced, multi-faceted tomatoey flavor. The indeterminate plants have an open habit and are very vigorous producers. Bred at Oregon State University.

Available only within the contiguous US.

[More Live Transplant Information](#)

OP Open Pollinated

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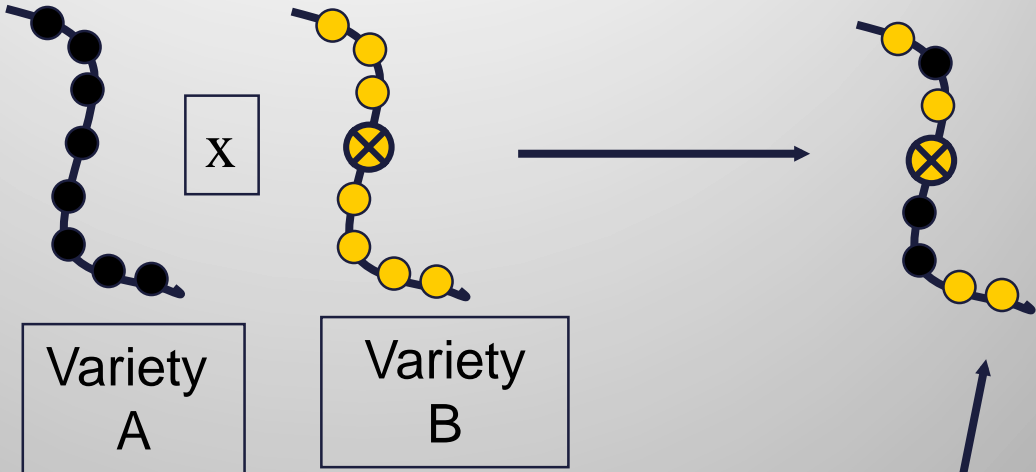


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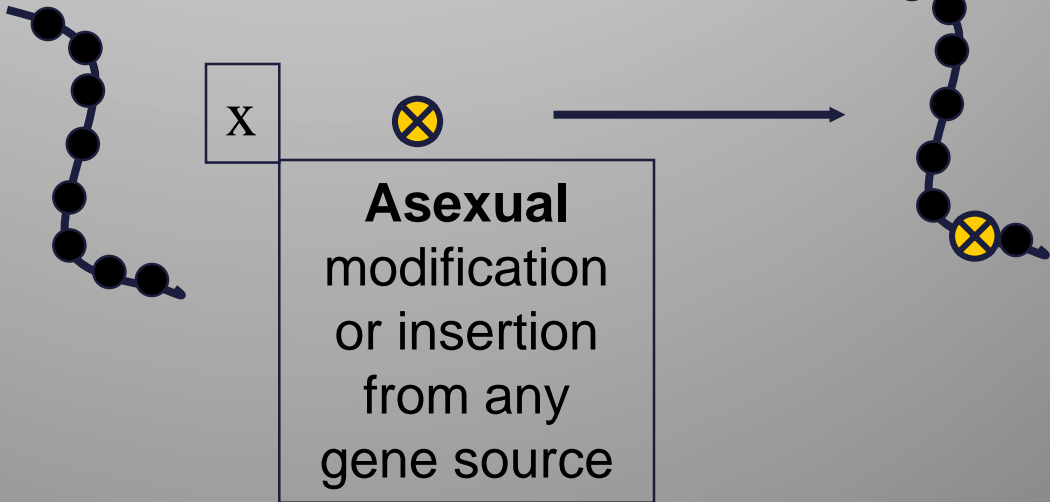
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GMO refers to a method of breeding with diverse outcomes

Traditional plant breeding



Genetic engineering



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

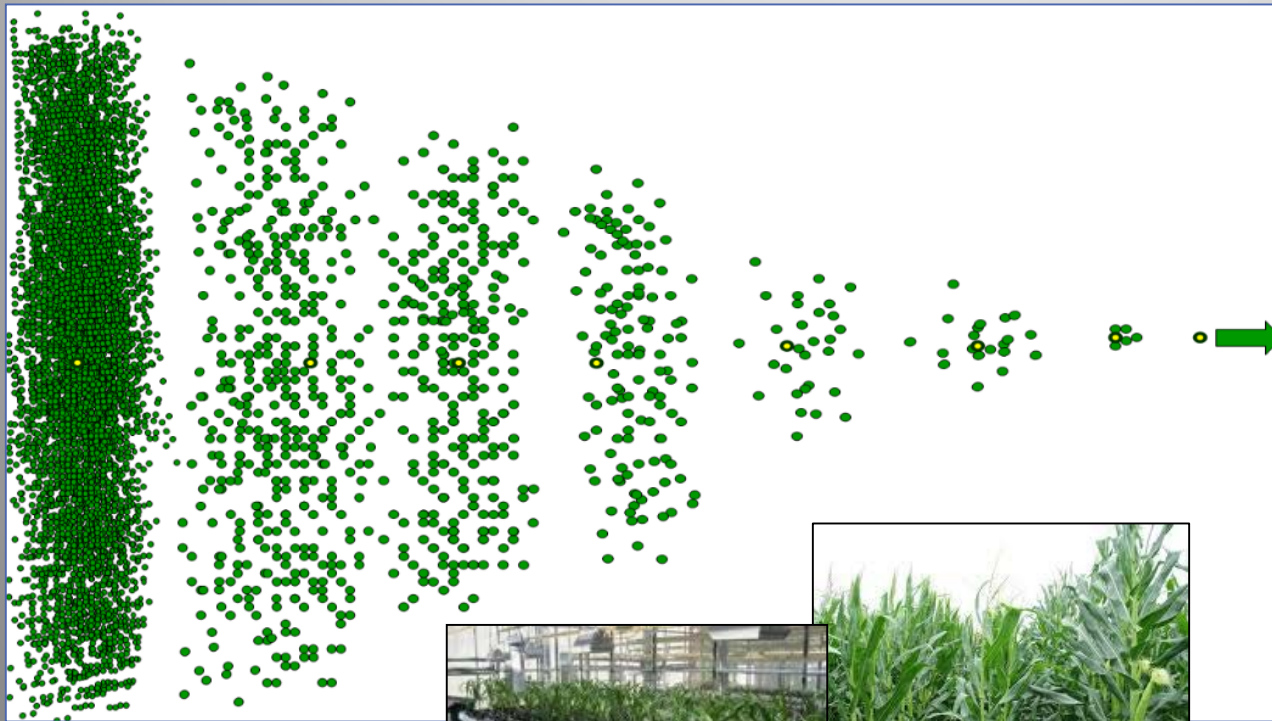


**Propagation in
tissue culture**



Growth in the field

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



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

ESA Report

GENETICALLY ENGINEERED ORGANISMS AND THE ENVIRONMENT: CURRENT STATUS AND RECOMMENDATIONS¹

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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 productive, more sustainable, resilient?
- If food becoming healthier, more nutritious?
- Are we using genetic methods to improve sustainability, healthfulness, productivity?
- There are no silver bullets: Are we making intelligent choices, management tactics, and tradeoffs to move in the right direction ?



Agenda

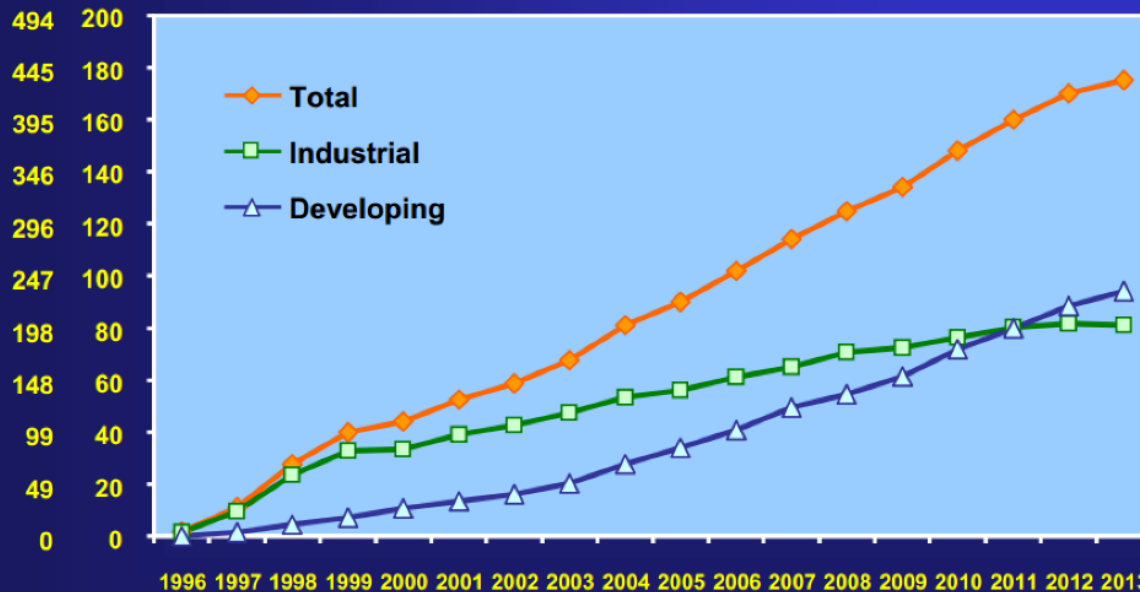
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First generation herbicide and insect resistant crops were rapidly adopted by farmers, both in the developed and developing world

**Global Area of Biotech Crops, 1996 to 2013:
Industrial and Developing Countries (M Has, M Acres)**



M Acres



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

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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.

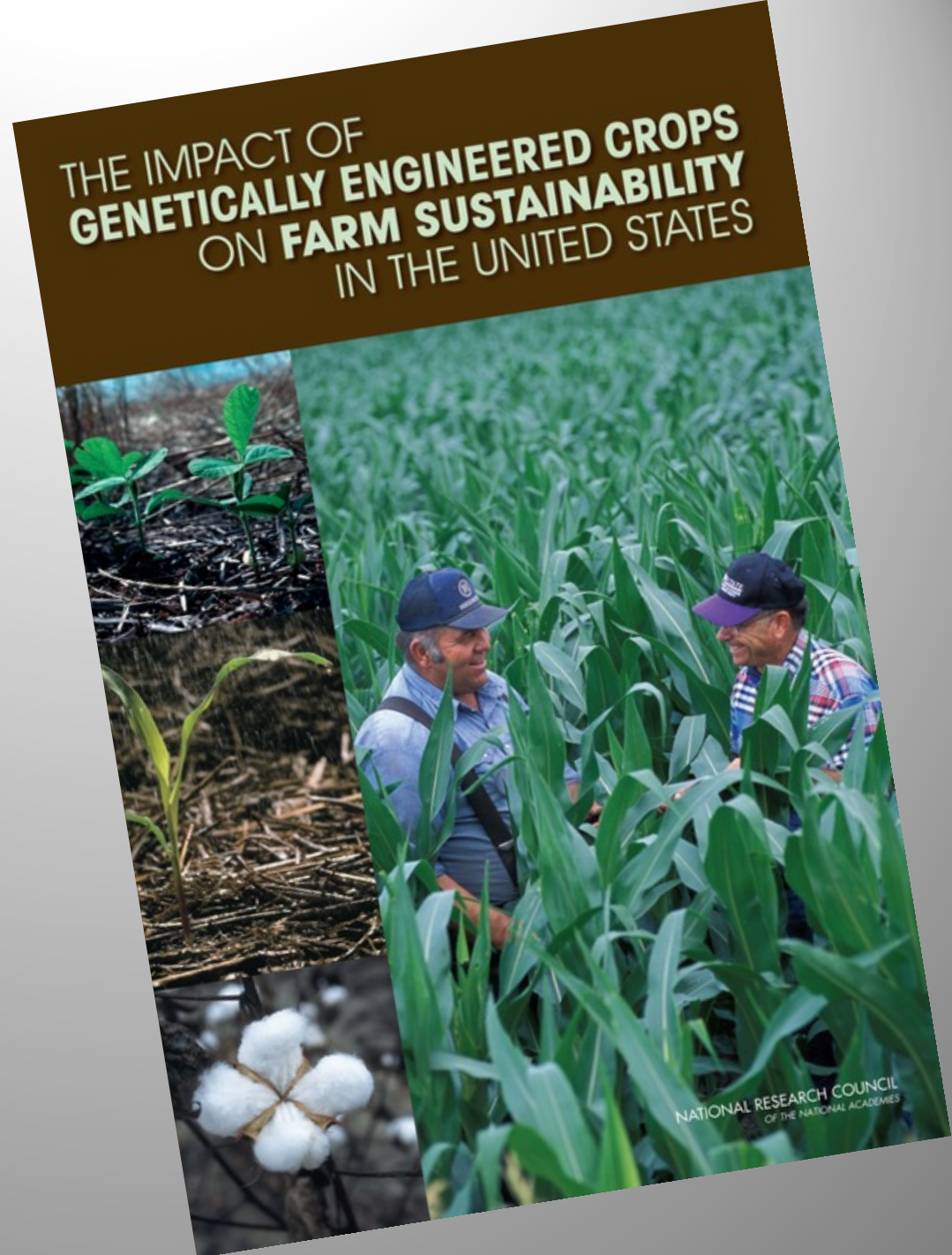
"This is not an argument to keep or lose GMOs," Tyner said. "It's just a simple question: What happens if they go away?"

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.

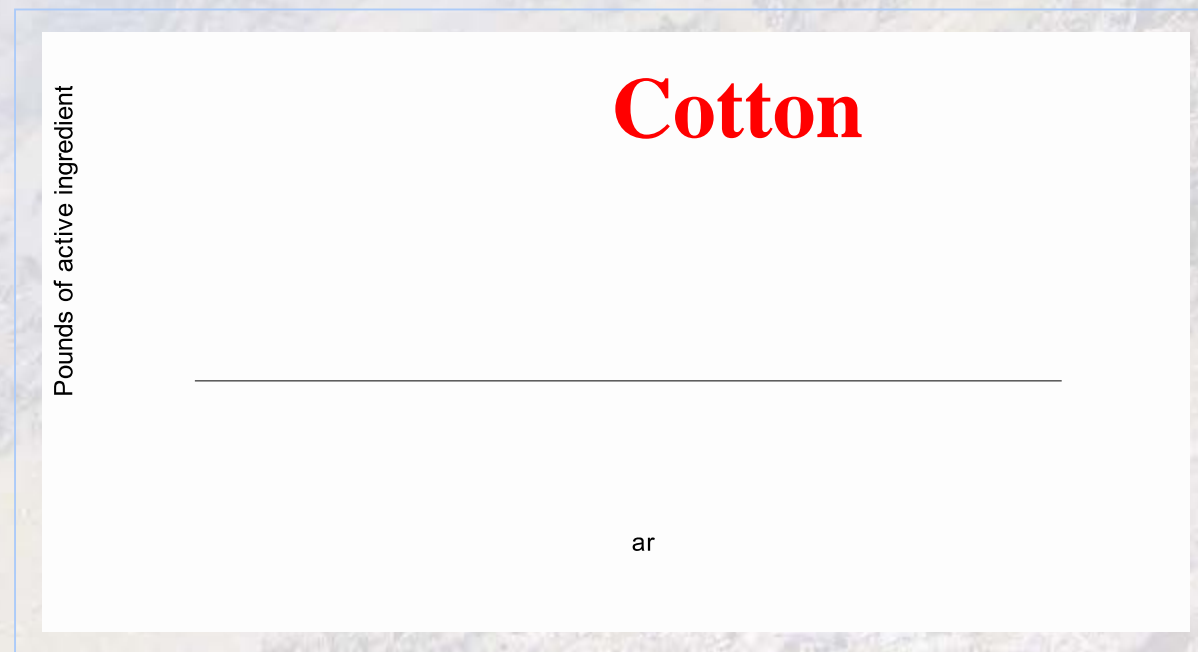
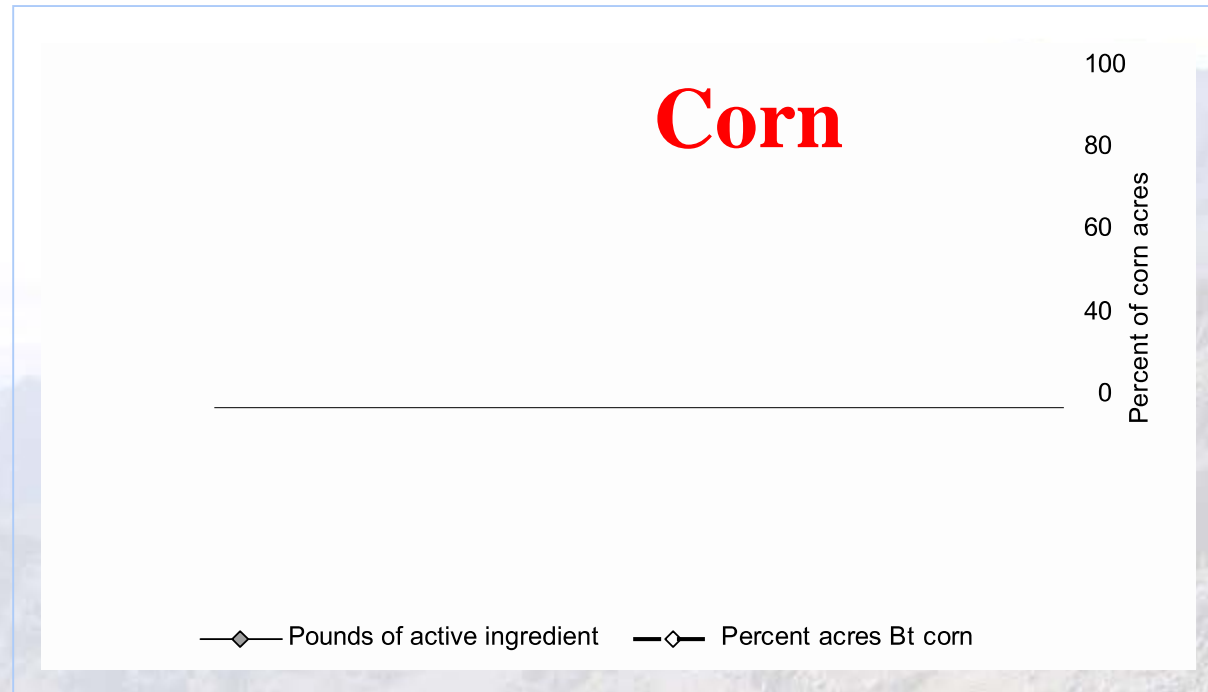
Many National Research Council reports on GMOs

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

The screenshot shows the PLOS ONE website interface. At the top left is the PLOS ONE logo. Navigation links for 'Subject Areas', 'For Authors', and 'About Us' are visible. A search bar is located at the top right. Below the navigation, the article is identified as 'RESEARCH ARTICLE' and is marked as 'OPEN ACCESS' and 'PEER-REVIEWED'. The title of the article is 'A Meta-Analysis of the Impacts of Genetically Modified Crops', authored by Wilhelm Klümper and Matin Qaim. The article was published on November 3, 2014, with a DOI of 10.1371/journal.pone.0111629. On the right side of the article header, there is a statistics table:

| | |
|--------------|-------------|
| 2 Saves | 0 Citations |
| 79,064 Views | 948 Shares |

“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)

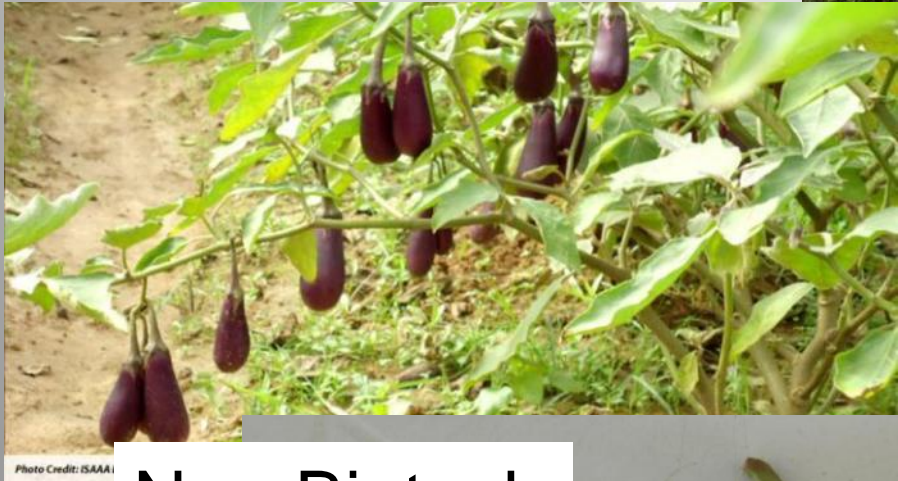


Photo Credit: ISAAA

Non-Biotech

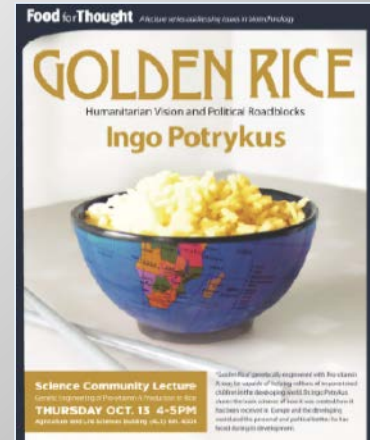
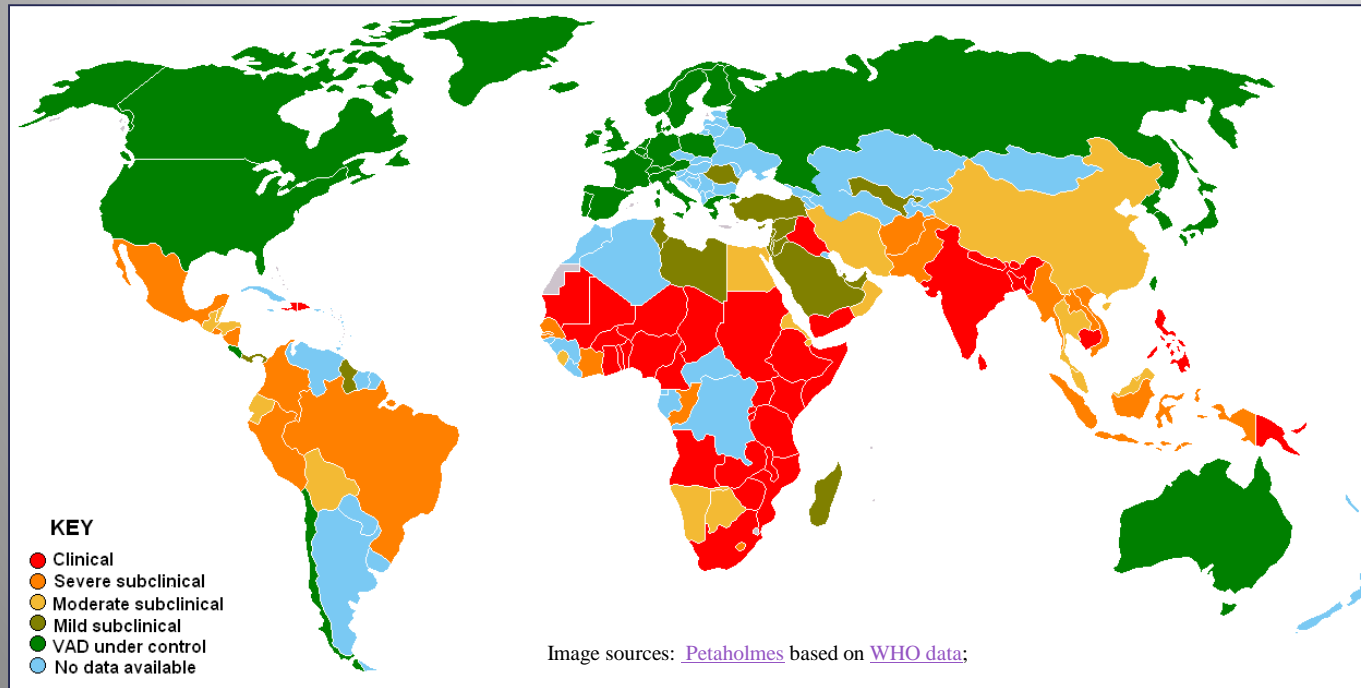


Biotech



Billions suffer from micronutrient deficiency

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



Young women suffering blindness due to Vit A deficiency

Vitamin A deficiency affects one-third of children 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



The Nobel Prize in Physiology or Medicine 2006
Andrew Z. Fire, Craig C. Mello

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The Nobel Prize in Physiology or Medicine 2006



Photo: L. Cicero
Andrew Z. Fire
Prize share: 1/2



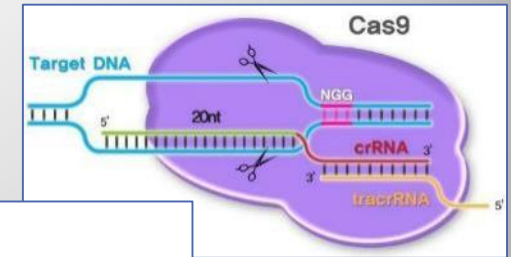
Photo: J. Mottern
Craig C. Mello
Prize share: 1/2

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"*

RNA
interference
(RNAi) for
gene
suppression

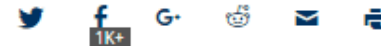
Nobel Prize
for its impact
and
mechanism

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

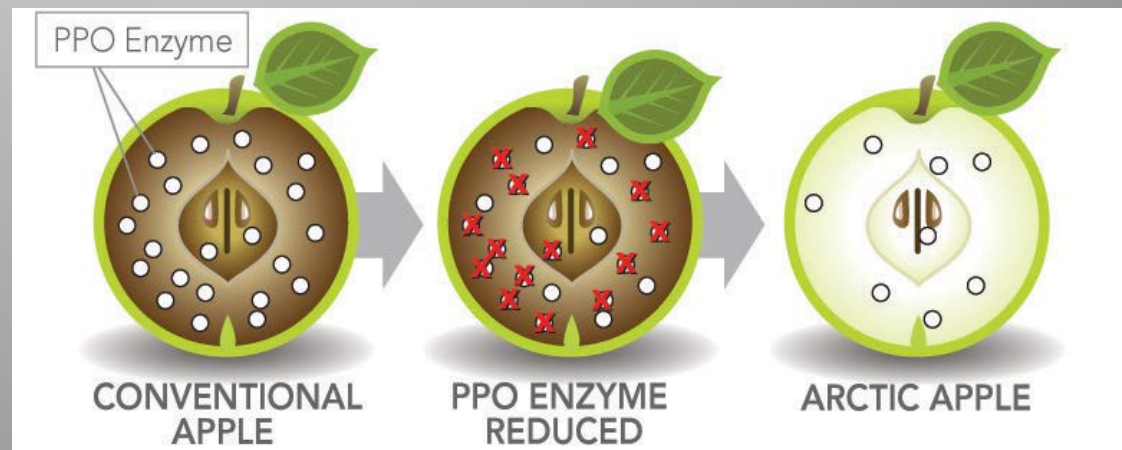


RNAi: Non-browning “Arctic Apple”

Reduced spoilage/waste, improved quality – USDA approved



Courtesy of Jennifer Armen,
Okanagan Specialty Fruits,
Canada



Non-browning “Arctic Apple”

Time lapse video





Arctic Apples

Genetically engineered to be non-browning when sliced.
Developed by a small Canadian company, Okanagan Specialty Fruits
Approved for consumption and cultivation in the US in Feb 2015

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 first ever genetically modified calves to have their DNA edited so that they do not grow horns, right. Jenn Ackerman for

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 BARNESDALE / AGSTOCKUSA /

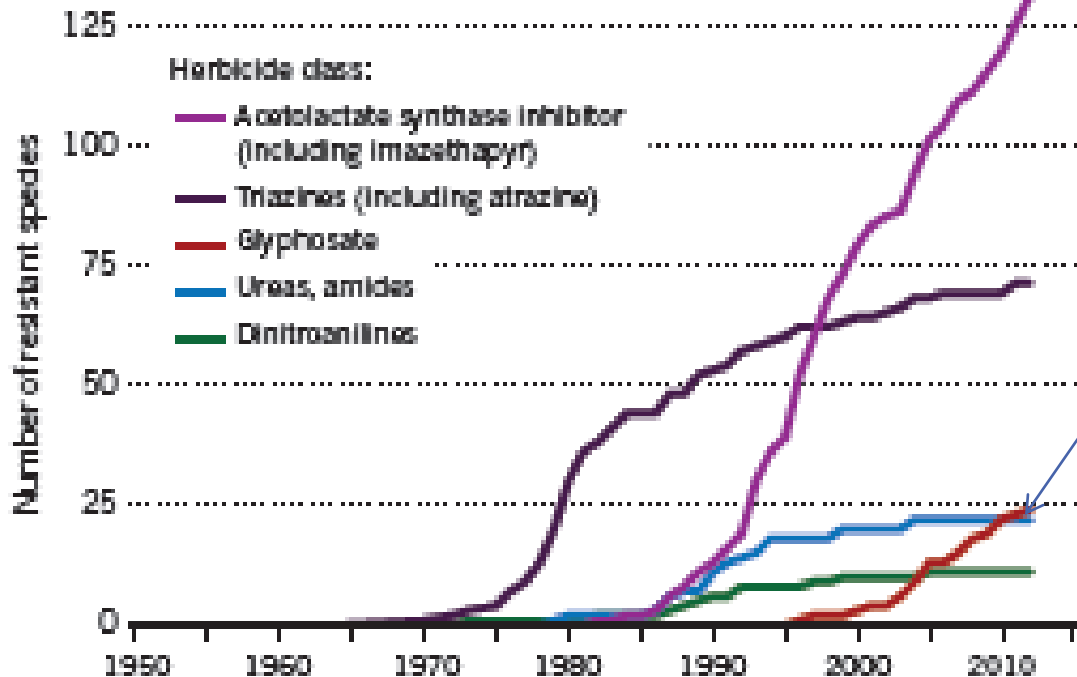


Herbicide-resistant weeds are an old problem in agriculture, but exacerbated by GE herbicide tolerant crops

THE RISE OF SUPERWEEDS

Weed species often become resistant to herbicides. Glyphosate resistance, once deemed unlikely, rose after genetically engineered crops were introduced in the mid-1990s.

SOURCE: UNIVERSITY OF CALIFORNIA, SURVEY OF HERBICIDE RESISTANT WEEDS WWW.WEB.EDUCATION.UMD.EDU/PLANTS/SCIENCE/PLANS/2009/



Accelerated by
GE Roundup-
tolerant crops



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

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

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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
21

Oregon with
major
coexistence
struggles due
to seed
industry, much
non-GMO
production &
many exports
2014 Task Force
Report

Governor's Task Force on Genetically Engineered Seeds and Agricultural Products

Task Force Report



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

Statesman Journal
A GANNETT COMPANY

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Voters reject proposal to ban GMO food in County

Associated Press 9:54 a.m. PDT May 20, 2015



In this May 1, 2015 photo, Oregon State University forestry professor Steven Strauss stands in a grove of genetically engineered poplar trees near Corvallis, Ore. Oregon State University says a Benton County ballot measure that seeks to ban the cultivation of genetically modified crops in

Top Quality
SAVE
PIC
S

No easy answers to coexistence problems

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

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There are numerous myths that are rampant and recycled in media



Vandana Shiva accuses multinational corporations such as Monsanto of attempting to impose "food totalitarianism" on the world.

Vicious anti-GMO messages widespread



And many more

I'm no ordinary apple
I'm a genetically modified one that never rots

[facebook.com/theorganicindian](https://www.facebook.com/theorganicindian)



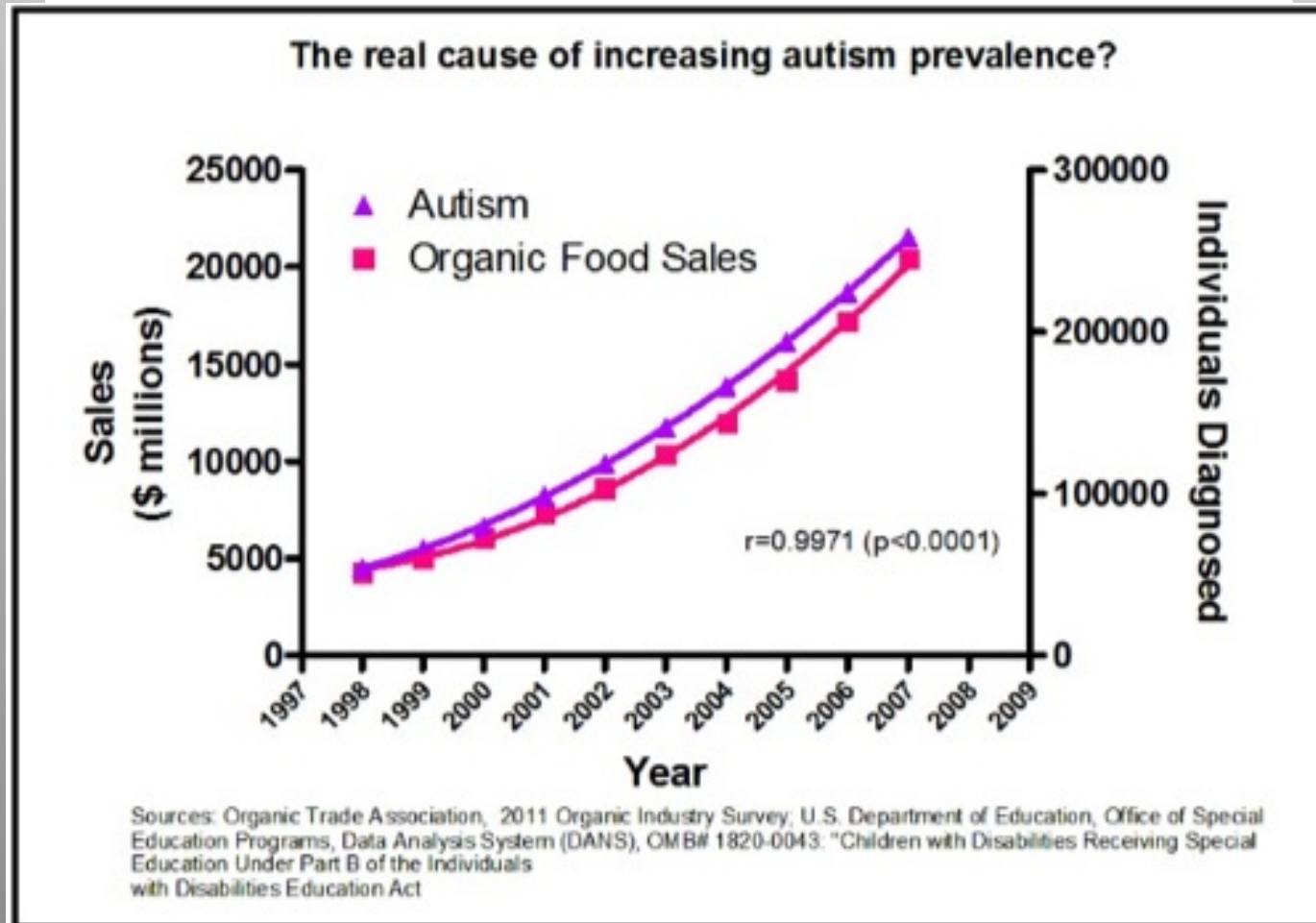
TAKE A BITE



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

Is GM food safe?

if an overwhelming majority of experts say something is true, then any sensible non-expert should assume that they are probably right



The American Association for the Advancement of Science (AAAS) is the directing and coordinating authority for health within the United Nations system.

The premier body of physicians in the United States has no scientific justification for special labeling of genetically modified foods.

The World Health Organization (WHO) is the directing and coordinating authority for health within the United Nations system.



The National Academy of Sciences is a former US government agency that has since become an independent body in the United States.

Europe's top medical society, the Royal Society of Medicine is an independent educational organization for doctors, dentists, scientists and those involved in medicine and health.

The European Commission (EC) is the executive body of the European Union.

"To date more than 98 million acres of genetically modified crops have been grown worldwide. No evidence of human health problems associated with the ingestion of these crops or resulting food products has been identified."

"Foods derived from GM crops have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."

"The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, involving more than 500 independent research groups, is that biotechnology, and in particular GM crops, are no more risky than e.g. conventional plant breeding technologies."



The American Council on Science and Health is a non-partisan group of scientists, educators, and public health experts who work to ensure that the environment stays a sound scientific and public health priority.

With the continuing accumulation of evidence, more and more consumers are becoming increasingly aware of the safety of GM foods.

The American Society for Cell Biology is a professional society devoted to the advancement of the plant sciences.

"The safety of genetically modified crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."

"The risk of unintended consequences of this type of gene transfer is comparable to the chance of gene transfer from natural sources, which is a very low risk. The safety of GM crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."

"The safety of genetically modified crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."



The ASM represents over 42,000 microbiologists worldwide.

"The ASM is not aware of any adverse effects that have been produced by biotechnology and genetic engineering in the United States. The risk of unintended consequences of this type of gene transfer is comparable to the chance of gene transfer from natural sources, which is a very low risk. The safety of GM crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."

"The safety of genetically modified crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."



The Crop Science Society of America (CSSA) is a professional society devoted to the advancement of the plant sciences.

"The safety of genetically modified crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."

"The safety of genetically modified crops is supported by a large body of scientific evidence, including the fact that GM crops are no more risky than e.g. conventional plant breeding technologies."



The International Society of Agricultural Biotechnology (ISAB) is a non-profit organization with the aim of raising the technical and scientific standards of agricultural biotechnology.

"Africa and the Caribbean cannot afford to be left further behind in acquiring the skills and scientific expertise that will be necessary to ensure the safety and benefits of this technology to their people."

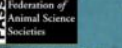
"Africa and the Caribbean cannot afford to be left further behind in acquiring the skills and scientific expertise that will be necessary to ensure the safety and benefits of this technology to their people."



Representing the American Dairy Science Association, the American Society of Animal Science, and the Poultry Science Association members.

"Meat, milk and eggs from livestock biotech foods are safe for human consumption."

"Meat, milk and eggs from livestock biotech foods are safe for human consumption."



The Society of Toxicology is a professional and scholarly organization of scientists from academic institutions, government, and industry practicing toxicology.

"Scientific evidence indicates that the products of GM crops are no more risky than e.g. conventional plant breeding technologies."

"Scientific evidence indicates that the products of GM crops are no more risky than e.g. conventional plant breeding technologies."



The Union of German Academies of Sciences and Humanities (ZAW) is a non-partisan group of scientists, educators, and public health experts who work to ensure that the environment stays a sound scientific and public health priority.

"The consumption of food from conventionally bred plants, GM crops, or both does not appear to be associated with any health risks."

"The consumption of food from conventionally bred plants, GM crops, or both does not appear to be associated with any health risks."



The International Council for Science (ICSU) is an international organization of scientists and academies in the natural and social sciences.

"Currently available genetically modified crops are no more risky than e.g. conventional plant breeding technologies."

"Currently available genetically modified crops are no more risky than e.g. conventional plant breeding technologies."

Is GM food safe?

if an overwhelming majority of experts say something is true, then any sensible non-expert should assume that they are probably right



The American Association for the Advancement of Science is an international non-profit organization AAAS serves some 261 affiliated societies and academies of science.

The premier body of physicians in the United States

The World Health Organization (WHO) is the directing and coordinating authority for health within the United Nations system.

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."

"There is no scientific justification for special labeling of genetically modified foods."

"No effects on human health have been shown as a result of the consumption of GM foods by the general population in the countries where they have been approved."

Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."



The National Academy of Sciences is a non-profit organization in the United States. It is the premier scientific body in the United States.

England's top medical society, the Royal Society of Medicine is an independent educational organisation for doctors, dentists, scientists and others involved in medicine and health care.

The European Commission (EC) is the executive body of the European Union.

"To date more than 98 million acres of genetically modified crops have been grown worldwide. No evidence of human health problems associated with the ingestion of these crops or resulting food products has been identified"

"Foods derived from GM crops have been consumed by hundreds of millions of people across the world for more than 15 years, with no reported health problems associated with their consumption."

"The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."

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

Safety of foods supported by many dozens of international science organizations

The scientific consensus around the safety of genetically modified foods is as strong as the scientific consensus around climate change. These foods are subjected to more testing than any other, and everything tells us that they're safe.

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
- Farm Animal Reform Movement
- Farm Aid
- Farm Sanctuary
- Friends of the Earth
- GRACE
- Government Accountability Project

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

- 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
- Nishoren
- No Spray coalition
- NWARN
- Organic Consumers Association
- PANNA
- PETA
- PCRM
- PIRG
- Public Citizen
- Purdey Fund
- Sierra Club
- SEAC
- Water Keeper Alliance



Pervasive online filters of information entrench, further polarize

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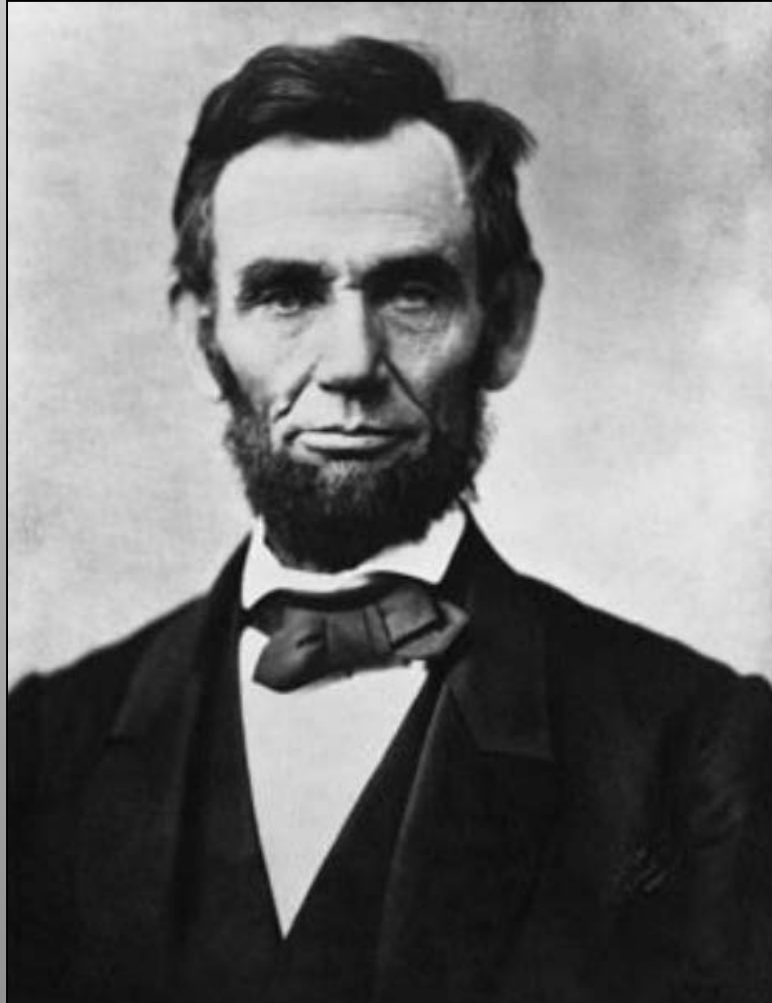


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Abe Lincoln warned us, but....



“Don’t believe everything you read on the Internet just because there’s a picture with a quote next to it.”

—Abraham Lincoln

<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

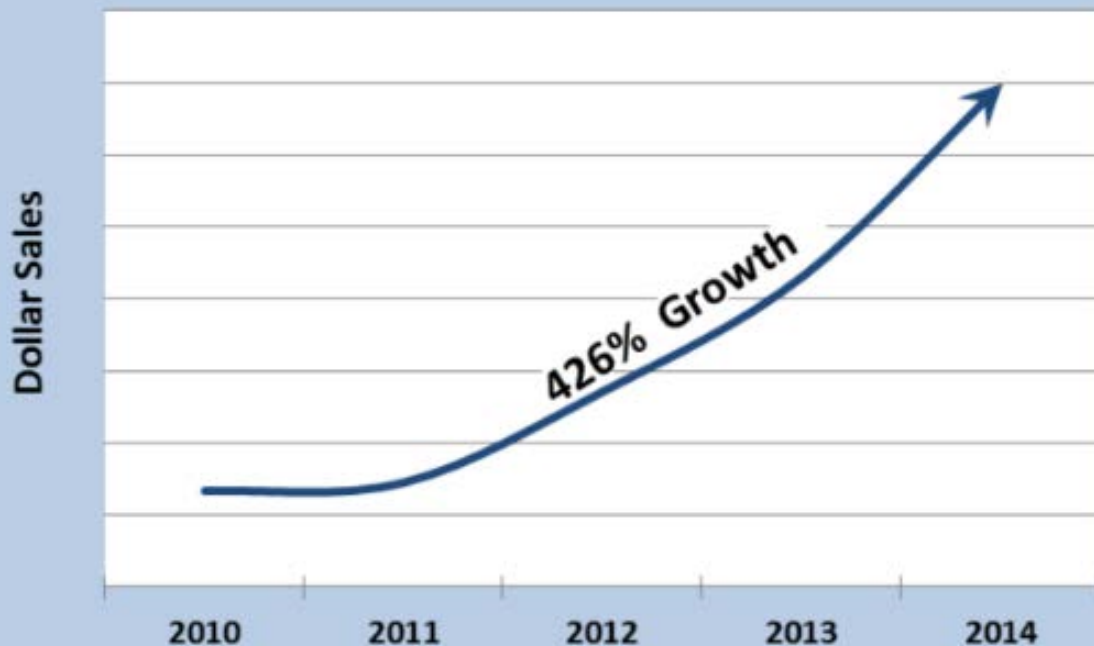
- GMO-free claims jumped 237% in new products 2012 to 2013



Organic and Non GMO Market
Growth 2015

Errol Schweizer
Executive Global Grocery Coordinator
Whole Foods Market

Non-GMO SALES



ORGANIC SALES



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

Food should taste good. It kind of wrote itself.
Pete
 Founder, Food Should Taste Good, Inc.
NOT MADE WITH GENETICALLY ENGINEERED INGREDIENTS

ALL PURPOSE SWEET POTATO Recipe:
 Use real sweet potatoes, that we have chosen, washed, and cut into 1/4" slices.

Nutrition Facts
 10 Sweet Potato Chips (10g)
 10 Sweet Potato Chips (10g)

| | | |
|--------------------|------|------|
| Total Fat | 1.5g | 3% |
| Sodium | 20mg | 0.4% |
| Total Carbohydrate | 18g | 36% |
| Fiber | 1g | 2% |
| Sugars | 0g | 0% |
| Protein | 1g | 2% |

INGREDIENTS:
 Stone Ground Corn, High Oleic Sunflower Oil and/or Safflower Oil, Potatoes, Cane Sugar, Sweet Potatoes, Sea Salt.

FOOD SHOULD TASTE GOOD
 I love food. I've been working in restaurants and grocery stores my whole life, and I've learned something: it's that food tastes best when it's made with real ingredients. That's why I founded my own company, dedicated to making wholesome snacks. As for the name, Food Should Taste Good, it kind of wrote itself.
Pete
 Founder, Food Should Taste Good, Inc.

NOT MADE WITH GENETICALLY ENGINEERED INGREDIENTS

GF CERTIFIED GLUTEN FREE

CERTIFIED VEGAN

SWEET POTATO chips are delicious alone or with:
 Fruit Salsa
 Raspberry Jam
 Apple Butter

Visit foodshouldtastegood.com for coupons and recipes or "like" us at [facebook.com/foodshouldtastegood](https://www.facebook.com/foodshouldtastegood) to enter our giveaways and contests.

JACKSON'S HONEST
Organic
 MADE WITH MULTIPLE CERTIFIED COCONUT OIL

SEA SALT POTATO CHIPS

Handmade in a small kitchen with love & honesty.

USDA ORGANIC

NON-GMO

NO MSG

NO ARTIFICIAL FLAVORS

NO ARTIFICIAL COLORS

NO SUGAR

NO TRANS FAT

NO HIGH FRUCTOSAMINE

NO HYDROLYZED VEGETABLE PROTEIN

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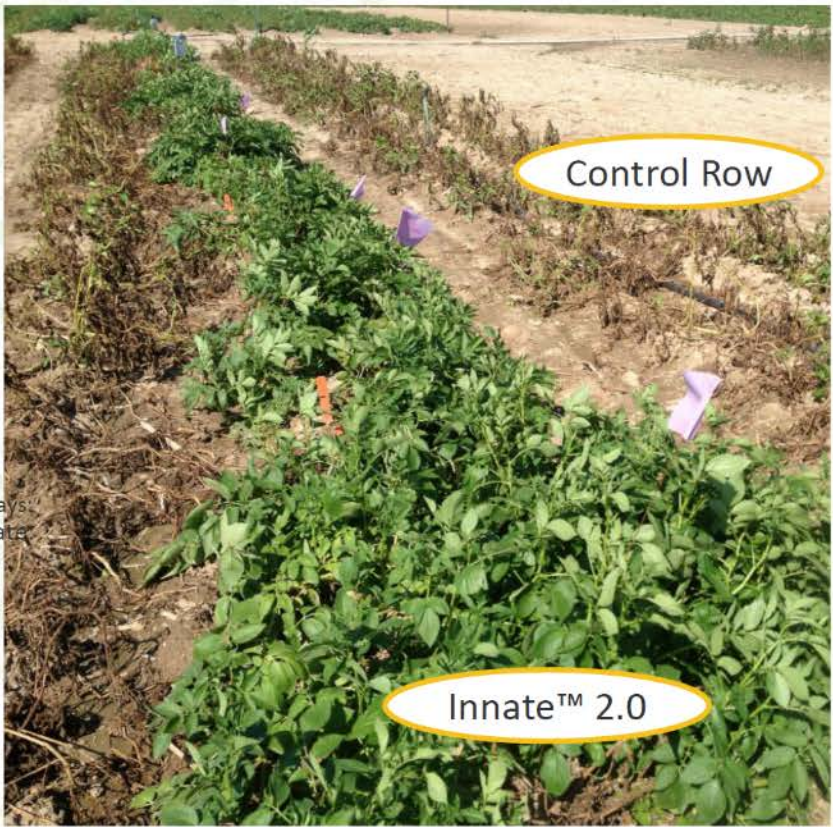
NO GLUTEN

NO NUTS

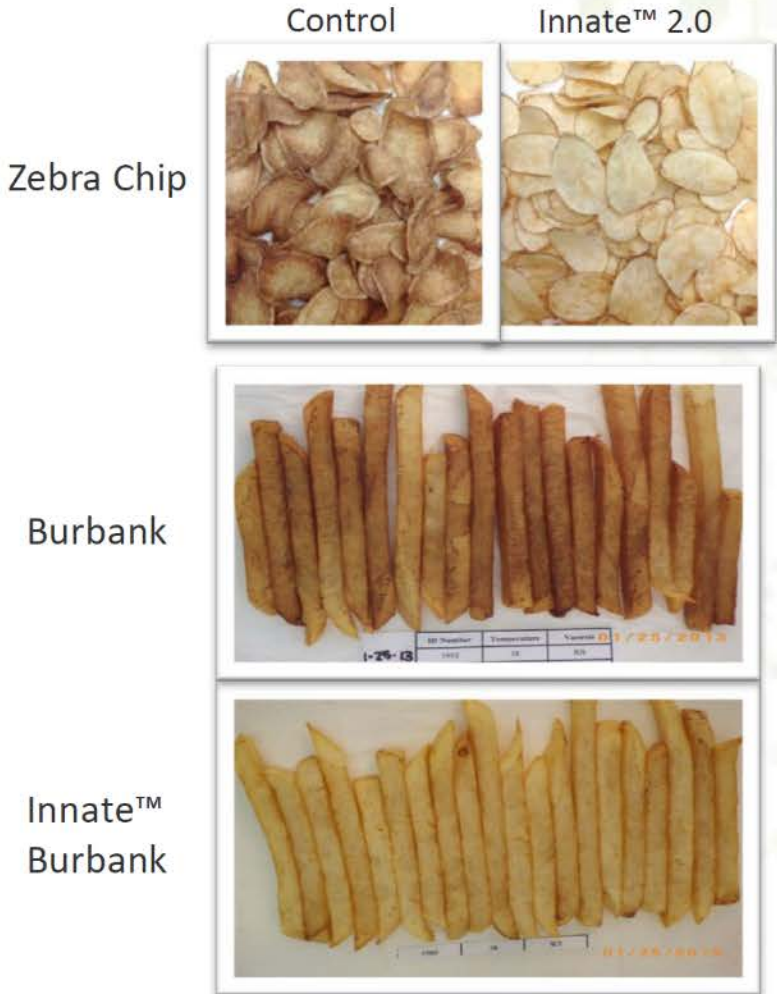
<

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

Midwest - Sept 4th 2013



Days
Rate

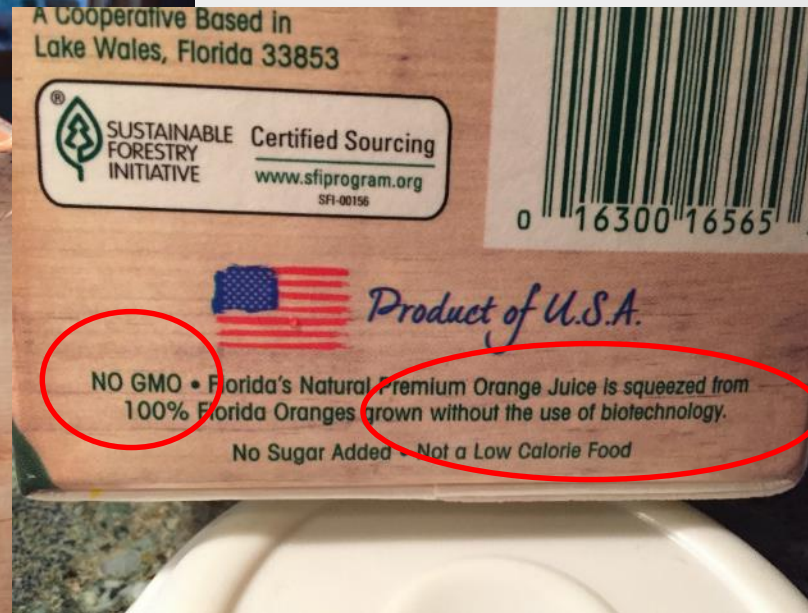


Potential Innate Potato benefits

- If all USA potatoes had it's improved traits, each year....
- Waste reduced by 5 billion pounds
- CO₂ 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



No-GMO claims on orange juice



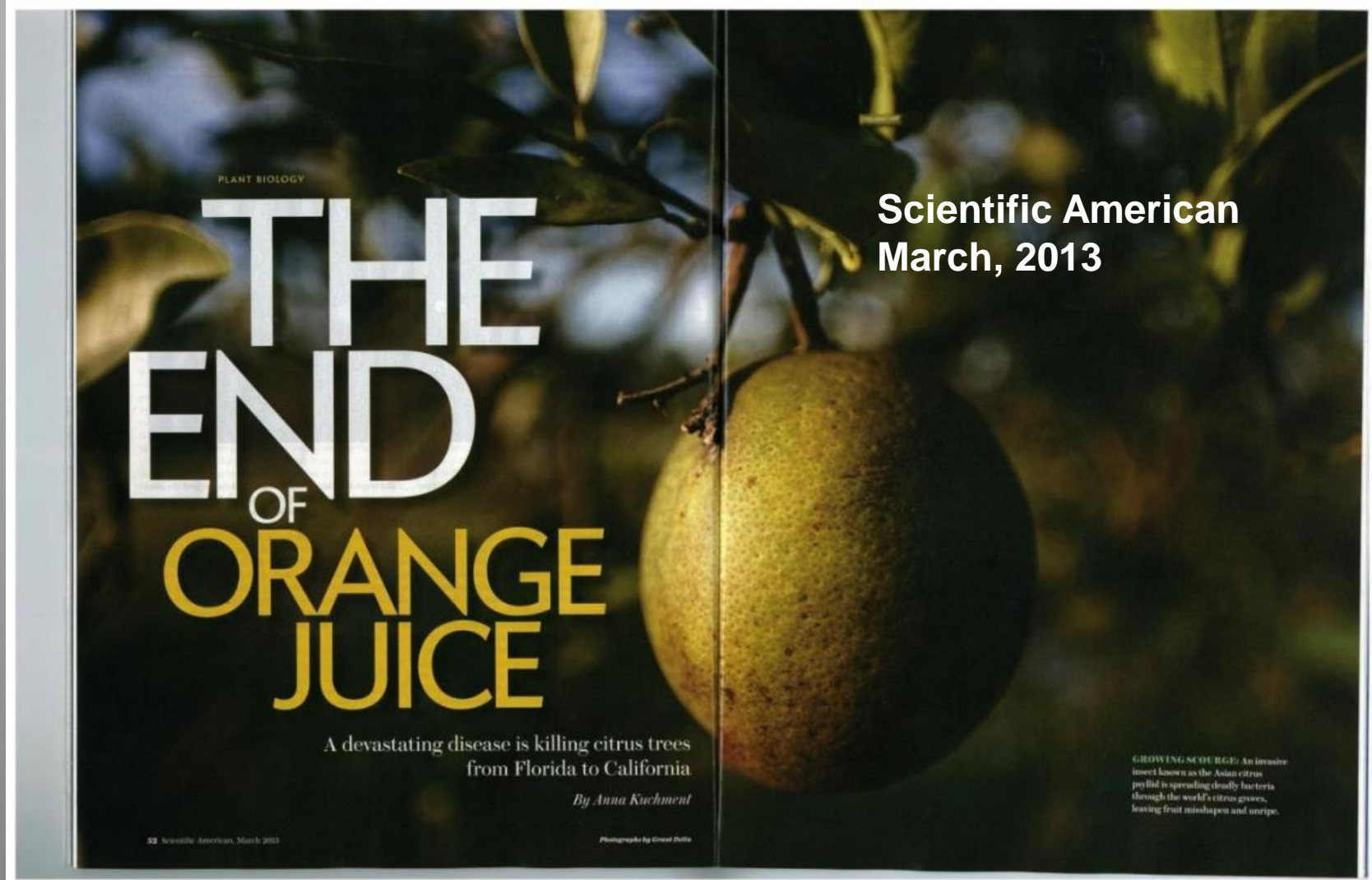
BUSINESS DAY

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

By STEPHANIE STROM DEC. 10, 2015

The New York Times

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



Scientific American
March, 2013

PLANT BIOLOGY

THE END OF ORANGE JUICE

A devastating disease is killing citrus trees
from Florida to California

By Anna Kuchment

52 Scientific American, March 2013

Photographs by Girard Dufin

GROWING SCOURGE: An invasive insect known as the Asian citrus psyllid is spreading deadly bacteria through the world's citrus groves, leaving fruit misshapen and stunted.

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)

AQUACULTURE 406/407:141-152 · MAY 2013

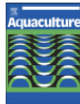


Aquaculture 406–407 (2013) 141–152

Contents lists available at SciVerse ScienceDirect

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,*}

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^c Aquabounty Canada, 6718 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

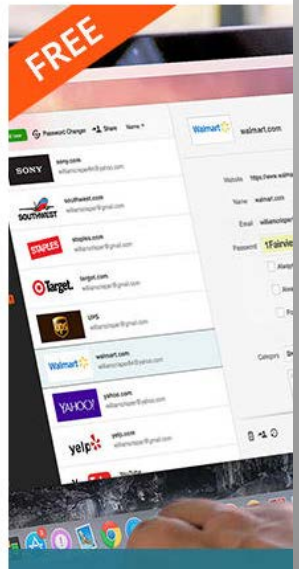
A [Print] [17] Save for Later Reading List

Earn up to a \$500 BONUS

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