Biotech in agriculture and food: Science, status and new developments

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

Ten statements about biotech/GMOs

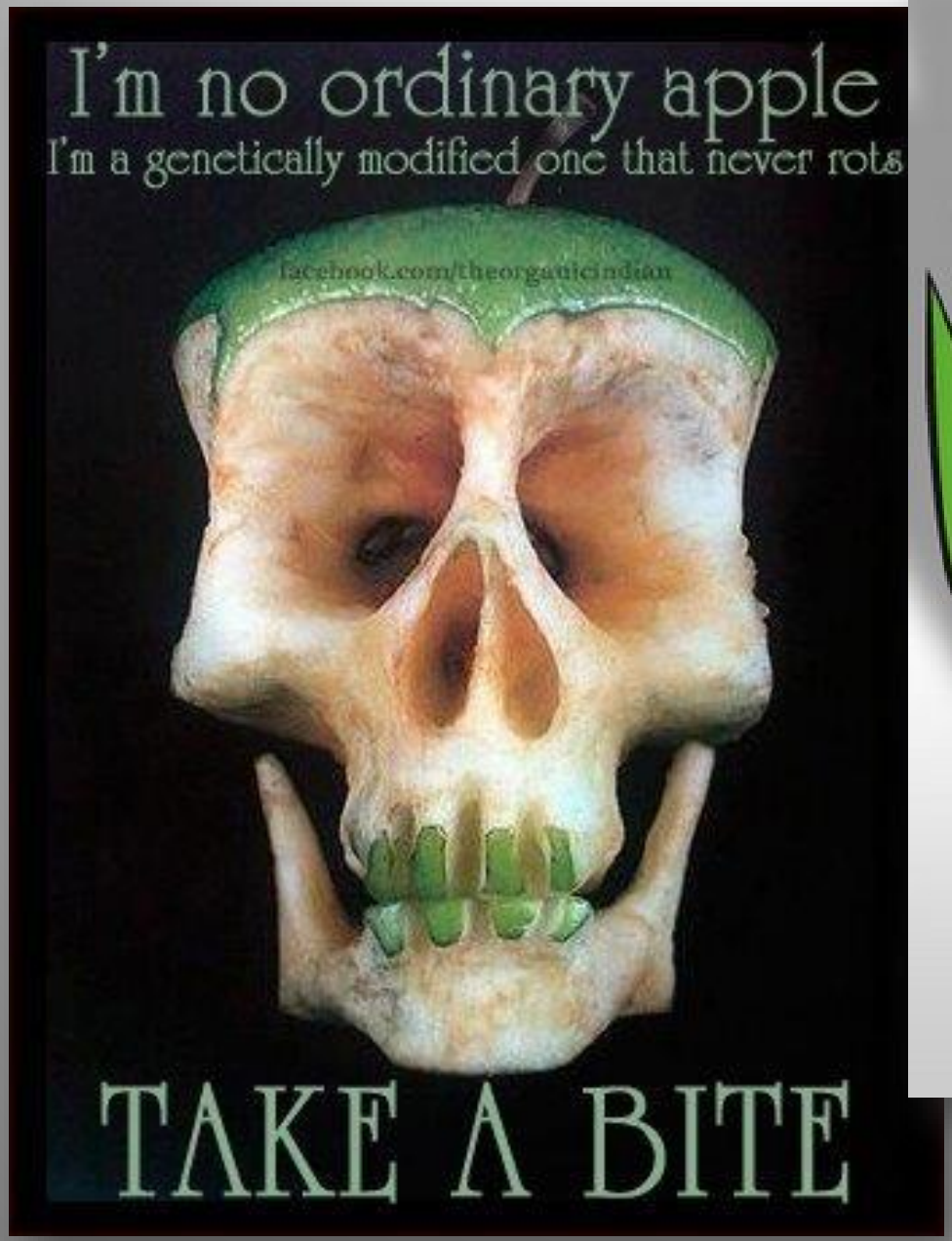
1. Complex, controversial
2. It's a method not a product
3. "Radical" non-GMO crop breeding
4. Rapid GMO uptake and large benefits
5. GMO problems and challenges
6. Simple answers and labels
7. Diversity of potential products
8. Approved GMO foods are safe
9. Gene flow and contamination myths
10. GMO vilification for profit in labels and beyond

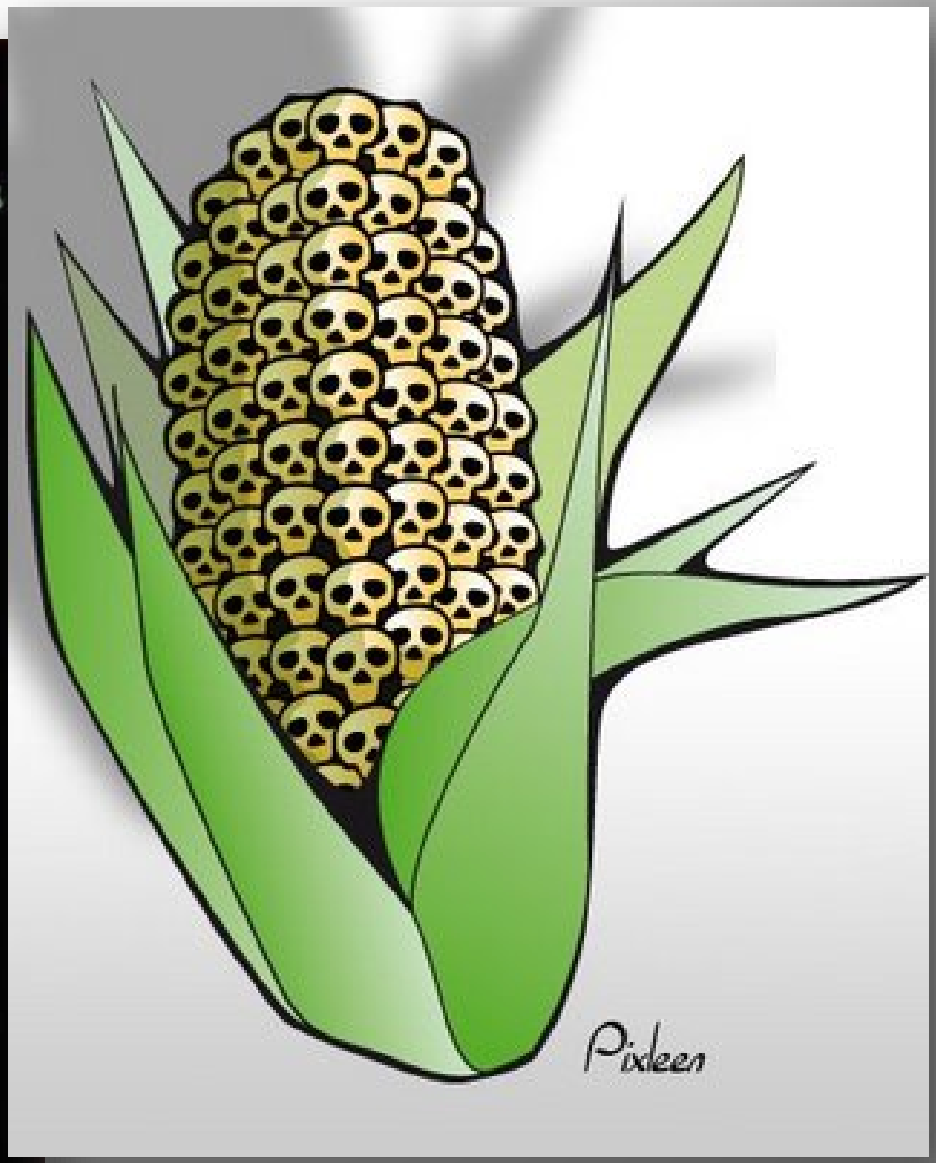
1. GE crop and food issues are **complex**, messy and extremely controversial

Avoid tribalism - Keep an open mind

There are numerous myths that are rampant and recycled in media

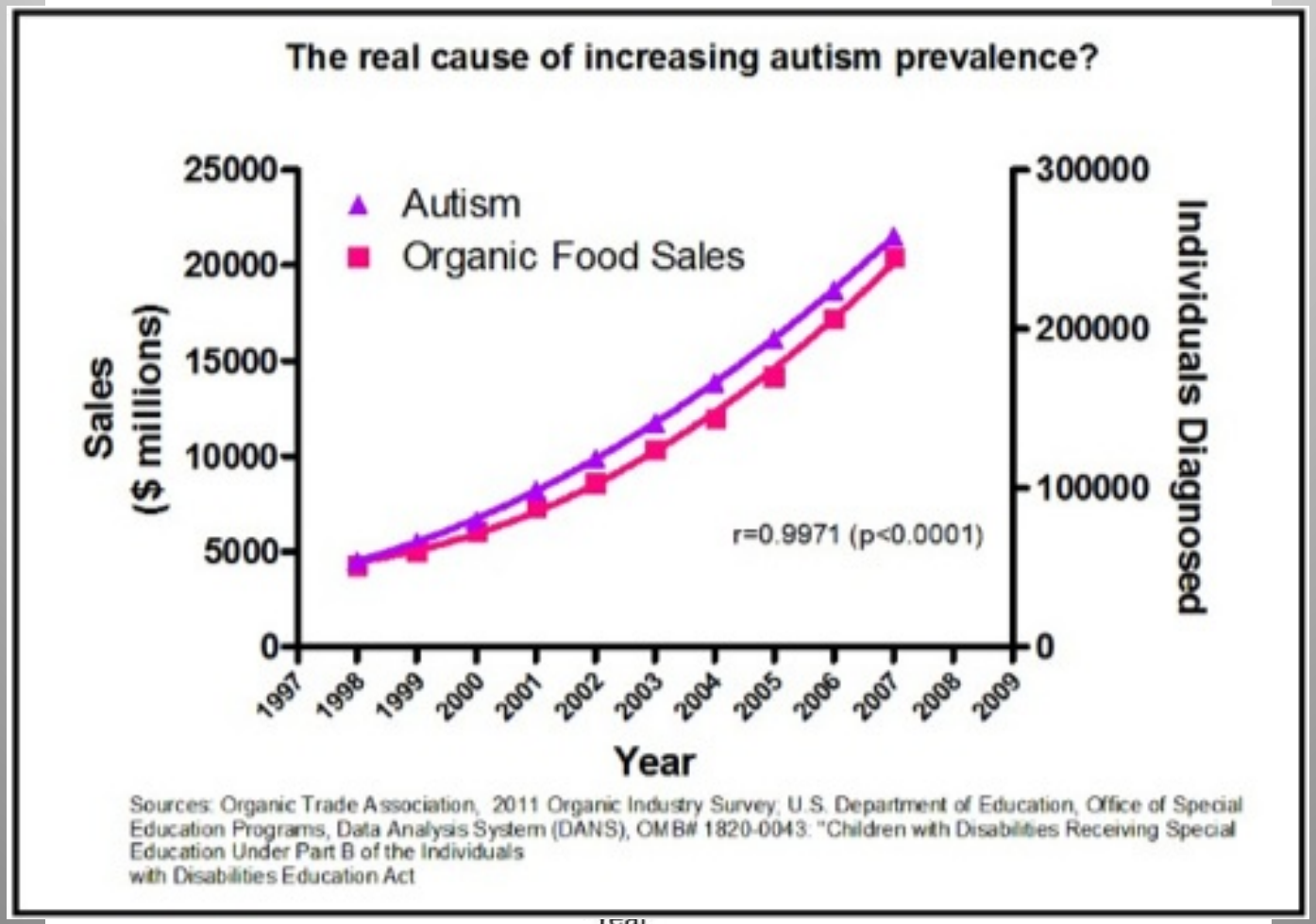
And many more…





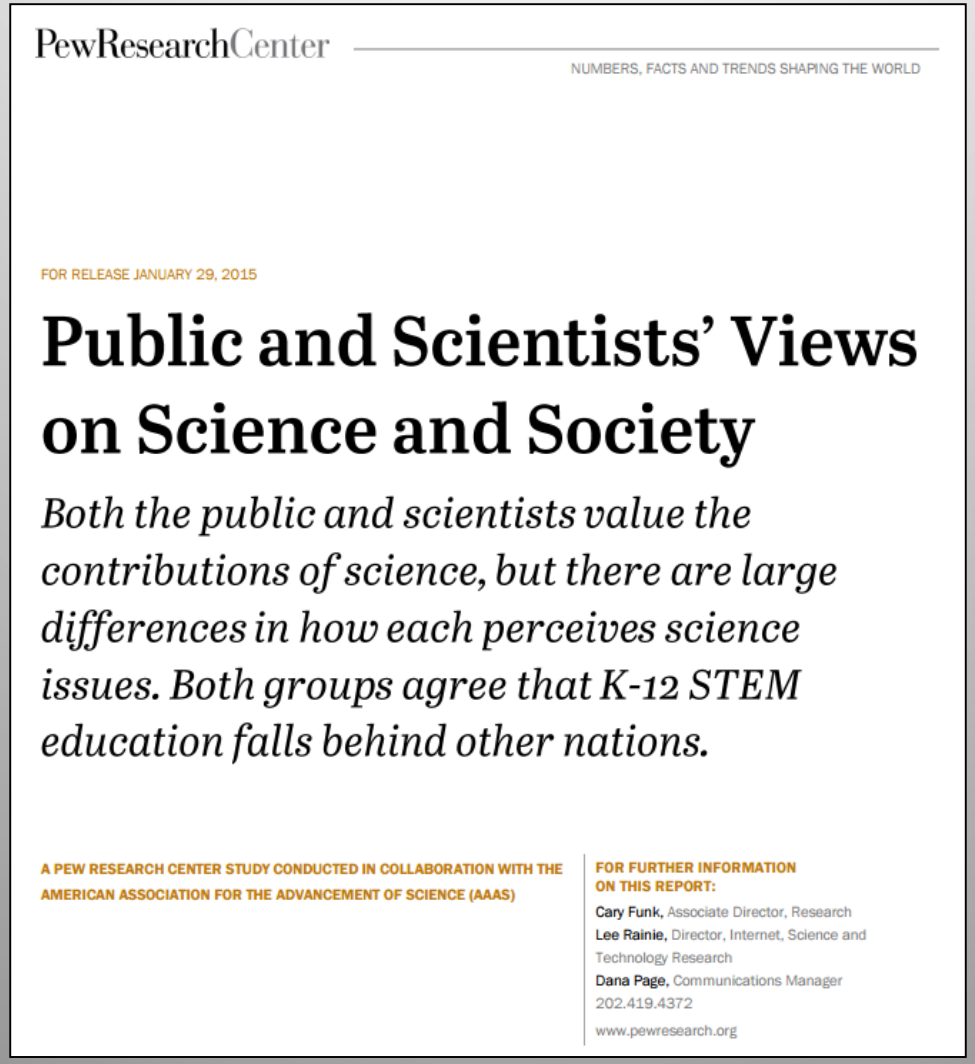
My colleague Steve Savage's favorite!

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



Food Evolution movie debunks the “data” of the extreme anti-GMO left, shows human need and benefits

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
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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/

Scientist views contrast with public on GMOs

PewResearchCenter *Internet, Science & Tech*

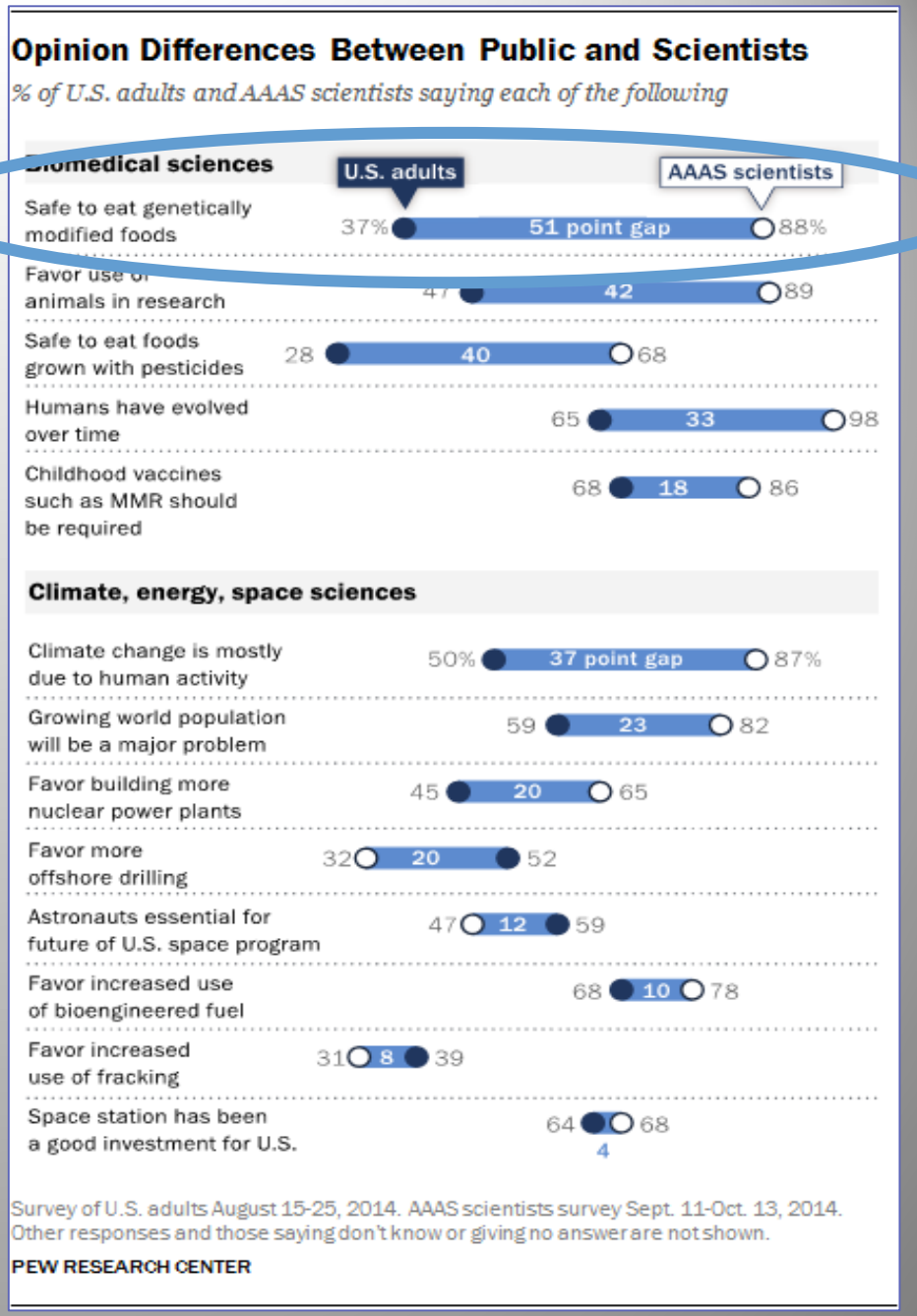
U.S. POLITICS | MEDIA & NEWS | SOCIAL TRENDS | RELIGION | INTERNE

PUBLICATIONS | TOPICS | PRESENTATIONS | INTERACTIVES | KEY INDICATORS

JANUARY 28, 2015

PUBLIC AND SCIENTISTS' VIEWS ON SCIENCE AND SOCIETY

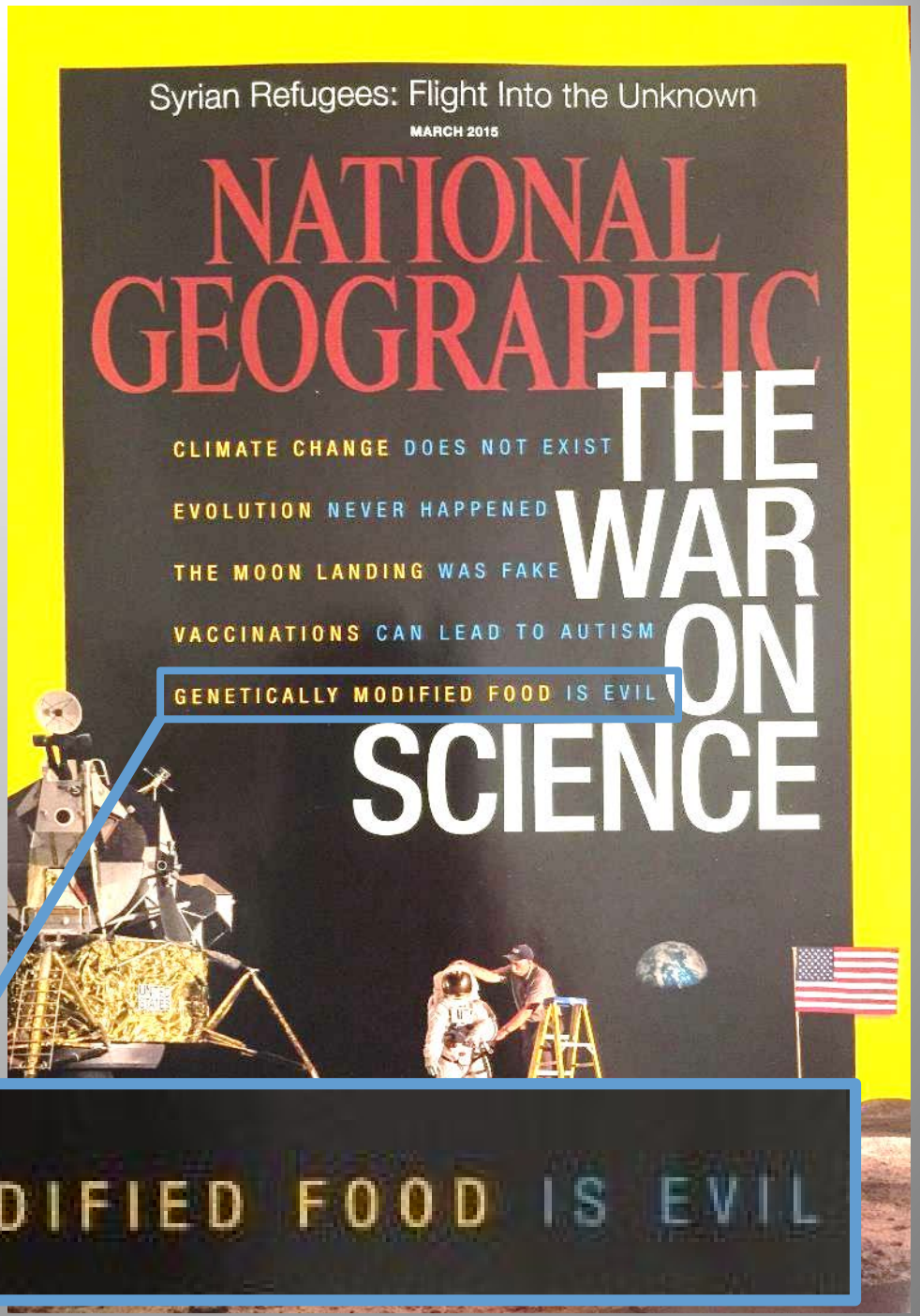
88% of AAAS scientists say genetically modified foods are safe to eat; only 37% of the public agrees



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

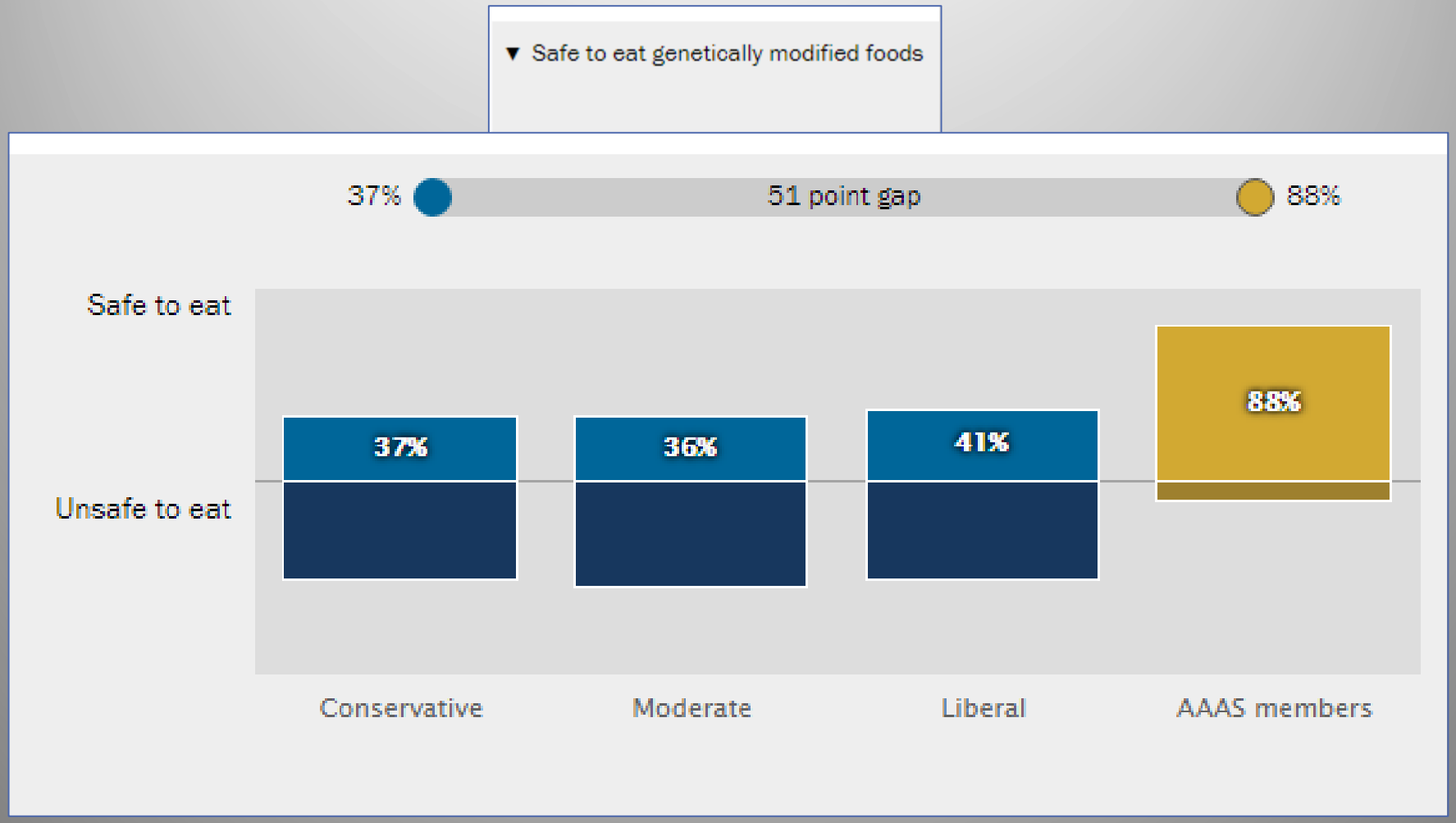
GMOs one of the "fake news - fake science" issues

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



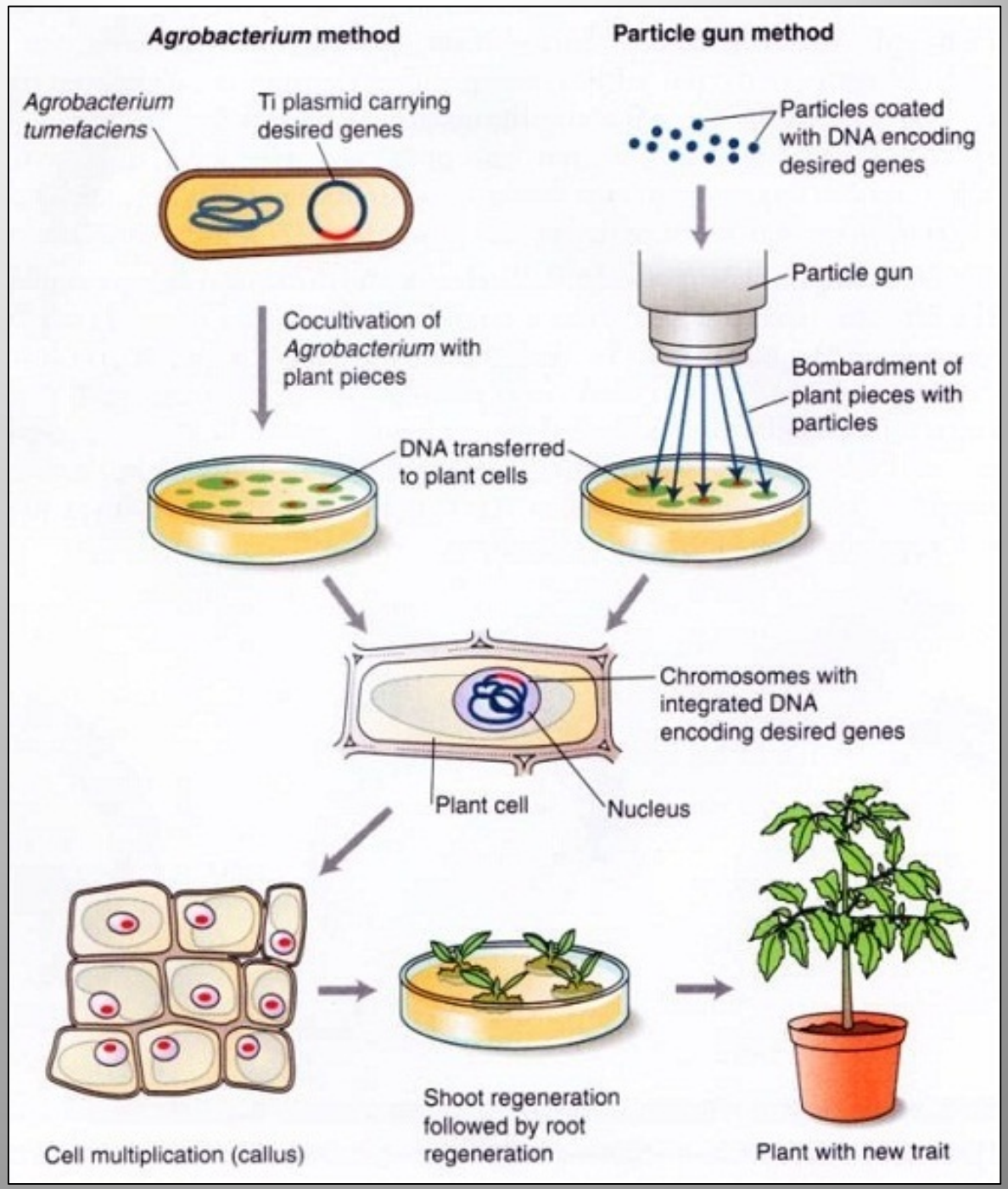
GENETICALLY MODIFIED FOOD IS EVIL

Unlike climate change, not clearly a left-right issue



2. GE is a **diverse set of methods**, not a specific product or mode of use

Steps to create a GE plant



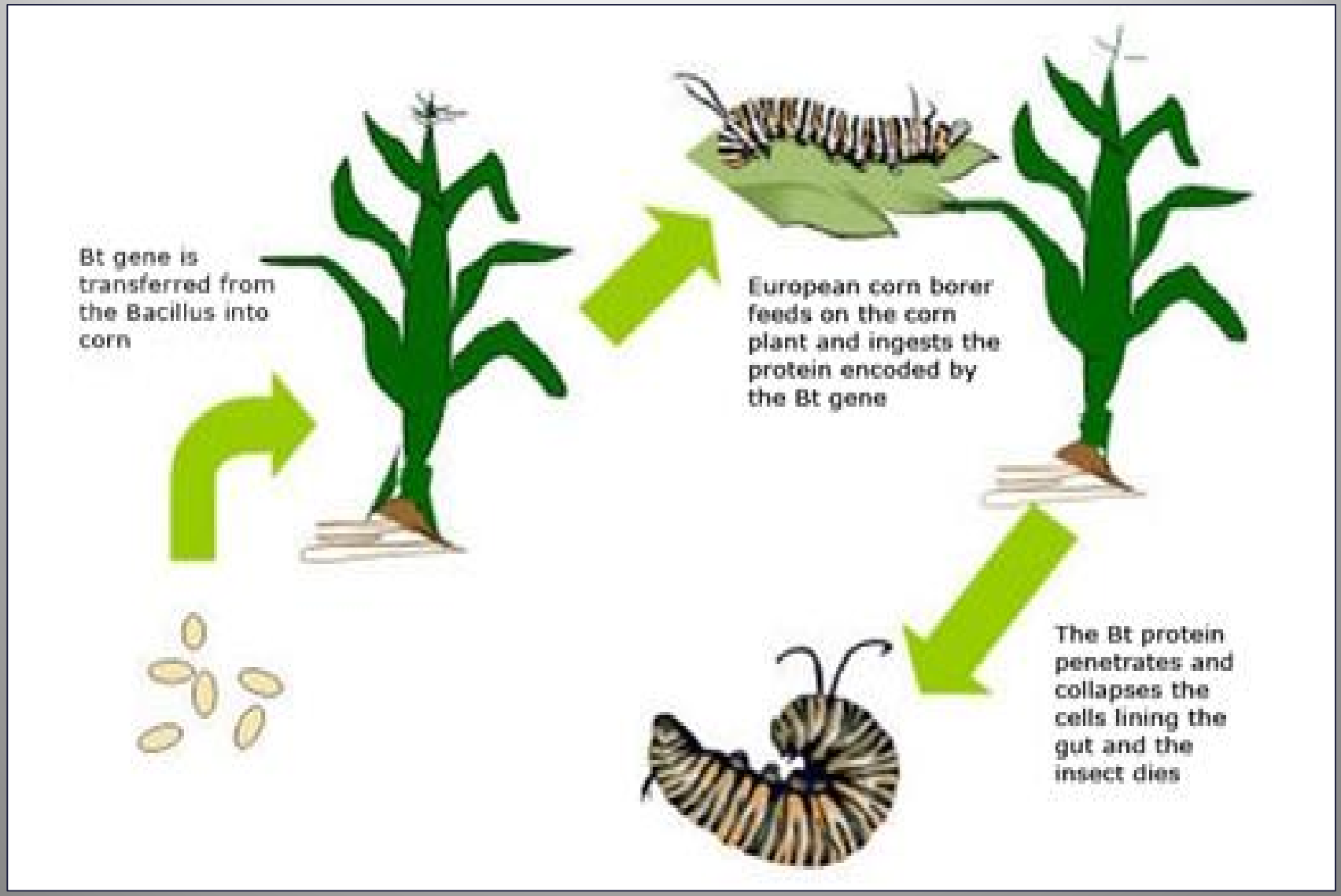
What is genetic engineering (GE)

- **Direct modification of DNA**
  - Vs. indirect modification in breeding
- **Asexually modified**, usually in somatic cells
  - Then regenerated into whole organisms, usually starting in Petri dishes

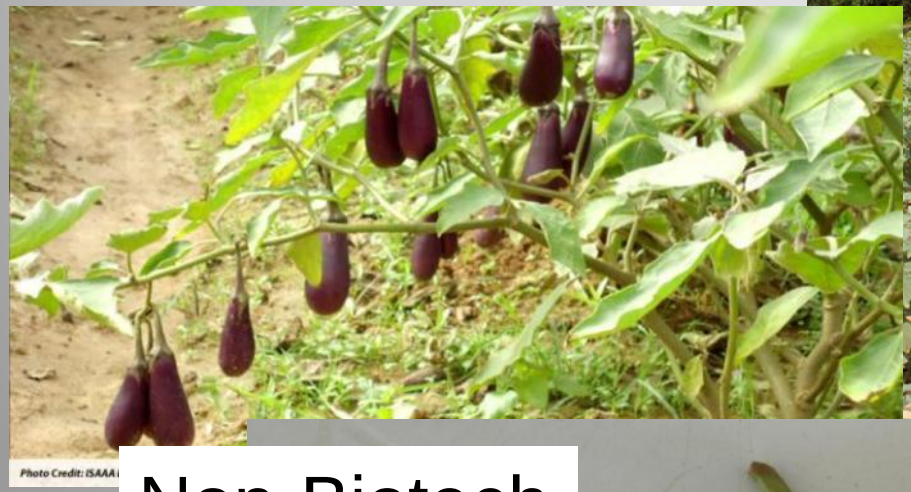
Insect-resistant “Bt crops”

More efficient and less harmful to non-targets than sprays --

Bt (*Bacillus thuringiensis*) sprays widely used in organic agriculture



A human face: Bt eggplant a solution to pesticide poisoning common in developing world (Bangladesh example)

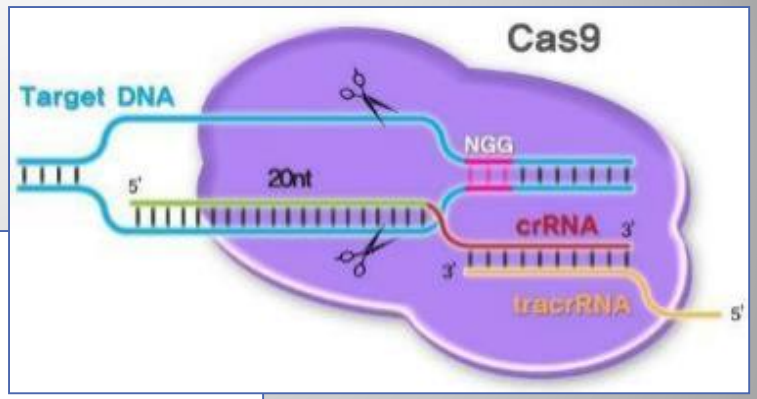


Non-Biotech

Biotech

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

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

nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

Dawn of the gene-editing age

PAGE 155

EVERYWHERE

CONSERVATION

A WORLD OF TWO HALVES

E. O. Wilson's vision for an Earth shared with nature

PAGE 170

PLANT BIOLOGY

FLOWER ARRANGEMENT

An attractant/receptor pair driving pollen-tube growth

PAGES 178, 241 & 245

GROUP DYNAMICS

THE RIGHT SIZE FOR A LAB

The skills mix and head count needed for success

PAGE 263

NATURE.COM/NATURE

10 March 2016 £10

Vol. 531, No. 7593

Recombinetics creates hornless cattle – mimics a natural mutation

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 two genetically modified calves to have their DNA edited so that they do not grow horns, right. Jenn Ackerman for The New York Times

The New York Times

Soybean with increased oleic acid

- Benefits to consumer and producer
  - Reduced saturated fats, no trans fats
  - Improved shelf-life without need for hydrogenation

Demorest *et al. BMC Plant Biology* (2016) 16:225
DOI 10.1186/s12870-016-0906-1

BMC Plant Biology

RESEARCH ARTICLE Open Access

Direct stacking of sequence-specific nuclease-induced mutations to produce high oleic and low linolenic soybean oil

Zachary L. Demorest, Andrew Coffman, Nicholas J. Baltes, Thomas J. Stoddard, Benjamin M. Clasen, Song Luo, Adam Retterath, Ann Yabandith, Maria Elena Gamo, Jeff Bissen, Luc Mathis, Daniel F. Voytas and Feng Zhang*

Gene editing to create reduced gluten wheat

- **Challenge**: 6 chromosomes (hexaploid), each with 7-8 copies of α-gliadin (gluten protein) genes
- **Result**: Efficiency of CRIRPR enable three nearly gluten-free wheat lines where most α-gliadin genes were mutated -- 60-85% reduction in gluten content

Plant Biotechnology Journal

aab Association of Applied Biologists

SEB Society for Experimental Biology

Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9

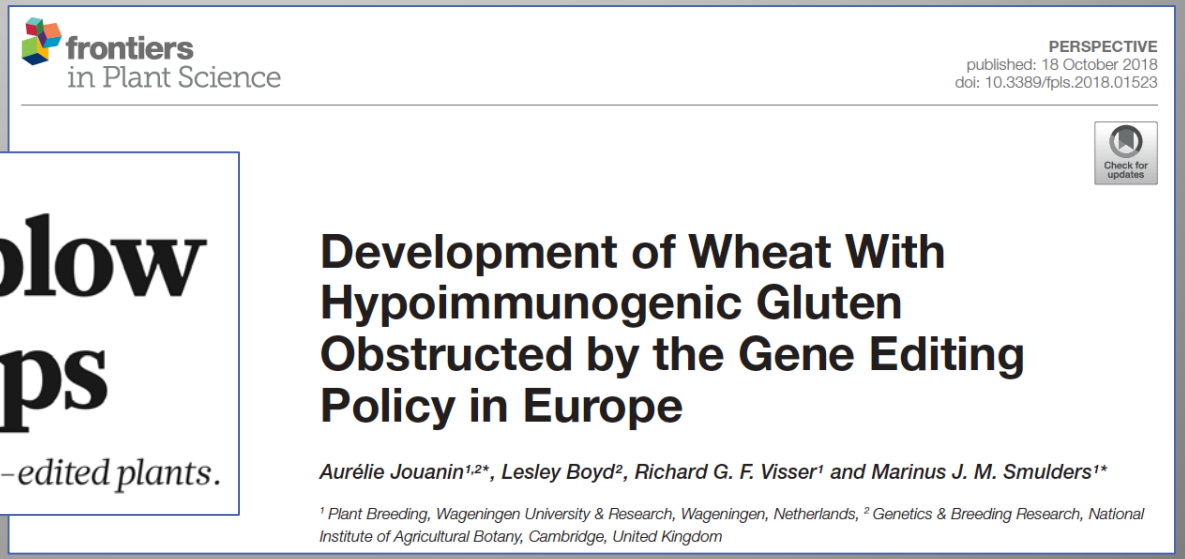
Susana Sánchez-León[1,#], Javier Gil-Humanes[2,*,#], Carmen V. Ozuna[1], María J. Giménez[1], Carolina Sousa[3], Daniel F. Voytas[2] and Francisco Barro[1,*]

[1]*Departamento de Mejora Genética Vegetal, Instituto de Agricultura Sostenible (IAS-CSIC), Córdoba, Spain*

[2]*Department of Genetics, Cell Biology, and Development, Center for Genome Engineering, University of Minnesota, Minneapolis, MN, USA*

Usability of gene edited products?

- USA rules unclear, would not now allow use of the most efficient biological gene transfer agent
- FDA proposes that all edited animals be regulated as new animal drugs
- EU considers as a GMO, with all the limits and stigma thereof



Are GE/GMO foods safe? Are they good for the environment?

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

- Genes/traits - Types of crops - Places
- Societies - Crop/Eco-systems
- Means of regulation & management

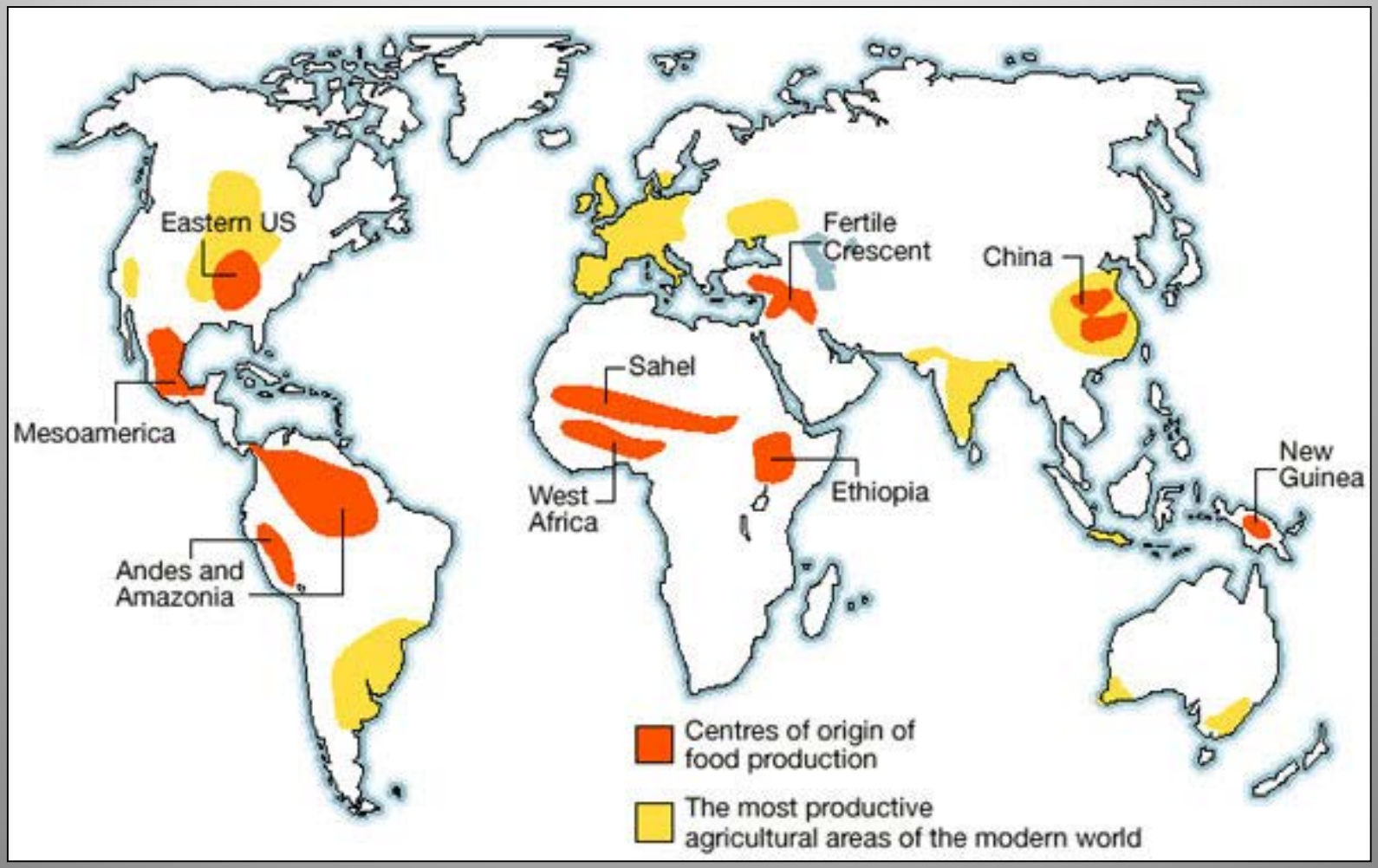
- **A general technology**: More like a wheel or computer than a specific medicine or saxophone

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

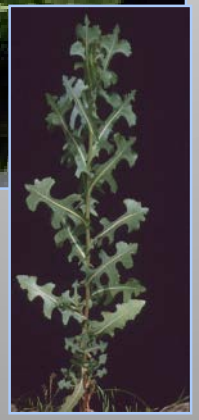
3. The most radically modified crops and foods are not GE

Where did our crops come from?

Answer: All over the world

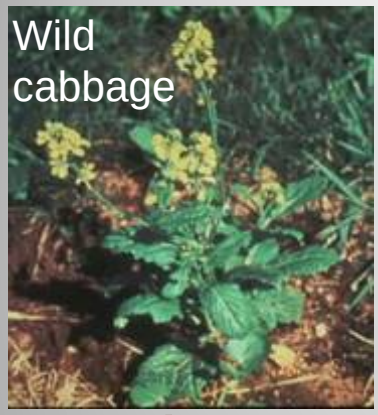


Most crops intensively bred, prior to GMOs



Mutants are some of our best friends:

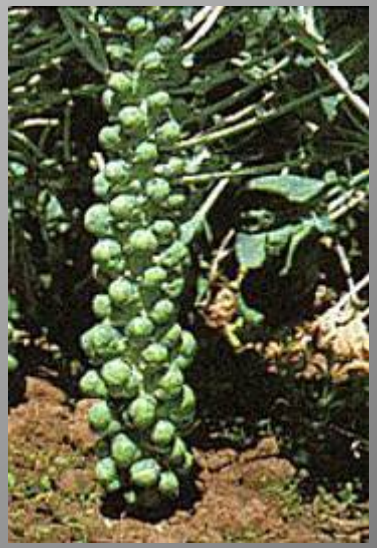
Domestication of wild cabbage



Kohlrabi
Germany, 100 AD

Ornamental kale
Late 1900's

Kale, 500 BC



Brussel sprouts
Belgium, 1700's

Breeding is continually changing varieties in response to markets, climate change, pests..

OSU wheat variety trials

University of Kentucky wheat variety trials

Oregon wheat traits of interest

- Grain yield
  - Yield stability
  - Broad adaptation
- Grain quality
  - Test weight
  - Kernel size, weight
  - Hardness
- Stress tolerance
  - Optimal maturity
  - Winter-hardiness
  - Straw strength
  - Drought tolerance
  - Heat tolerance

- Disease resistance
  - Stripe rust
  - Leaf and stem rust
  - Strawbreaker footrot
  - Cephalosporium stripe
  - Fusarium crown rot
  - Dryland footrots
  - Septoria tritici
  - Septoria nodorum
  - Mildew
- Insect resistance
  - Hessian fly

Sources of genes include mutation breeding

- 3,217 registered varieties developed from mutation breeding
  - FAO/IAEA database (http://www-infocris.iaea.org/MVD/)
- DNA changes include deletions, insertions, inversions

Institute of Radiation Breeding
Ibaraki-ken, JAPAN
www.irb.affrc.go.jp/

Radical changes in domesticated animals

All dogs derived from the wolf by breeding







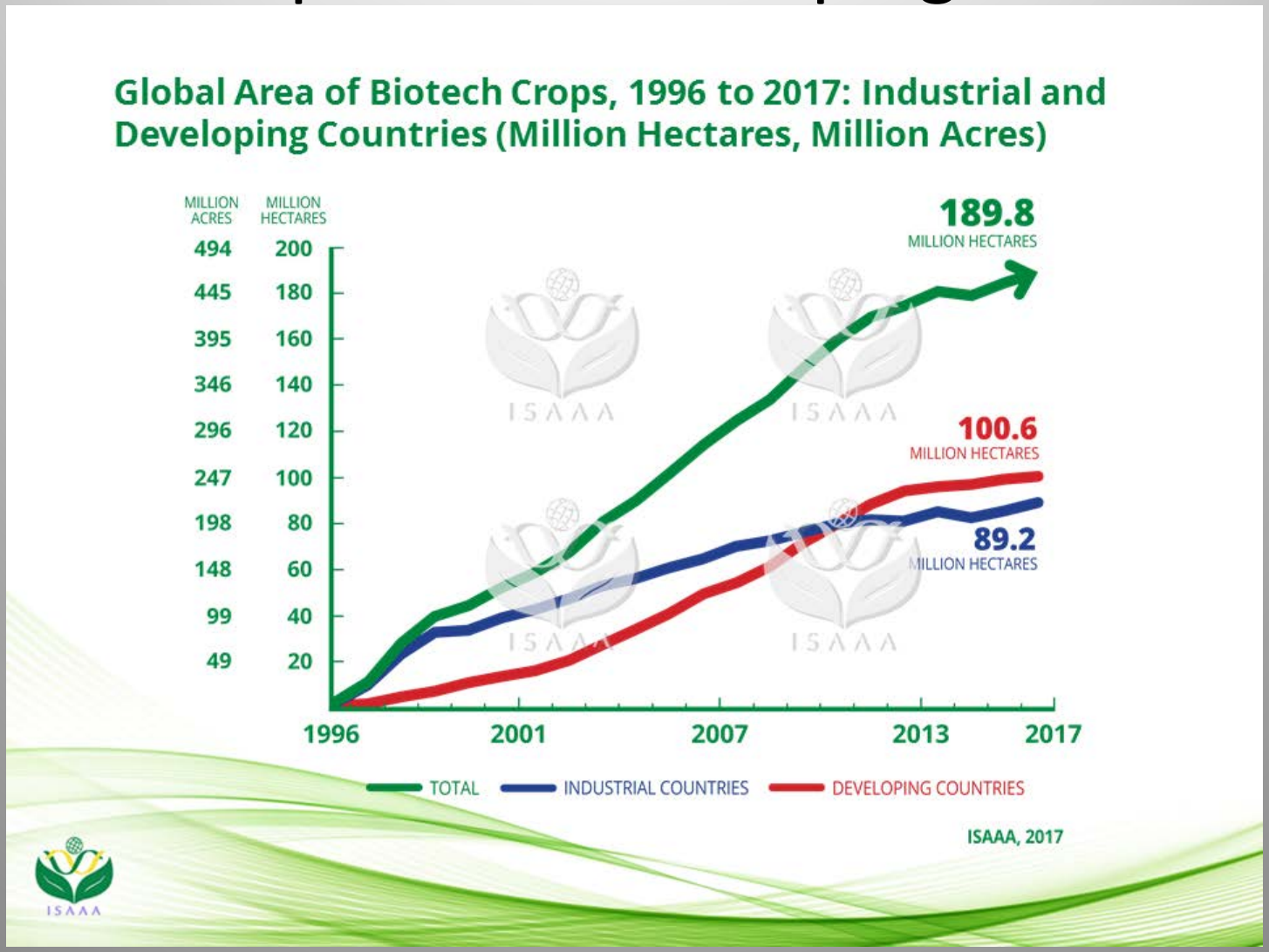




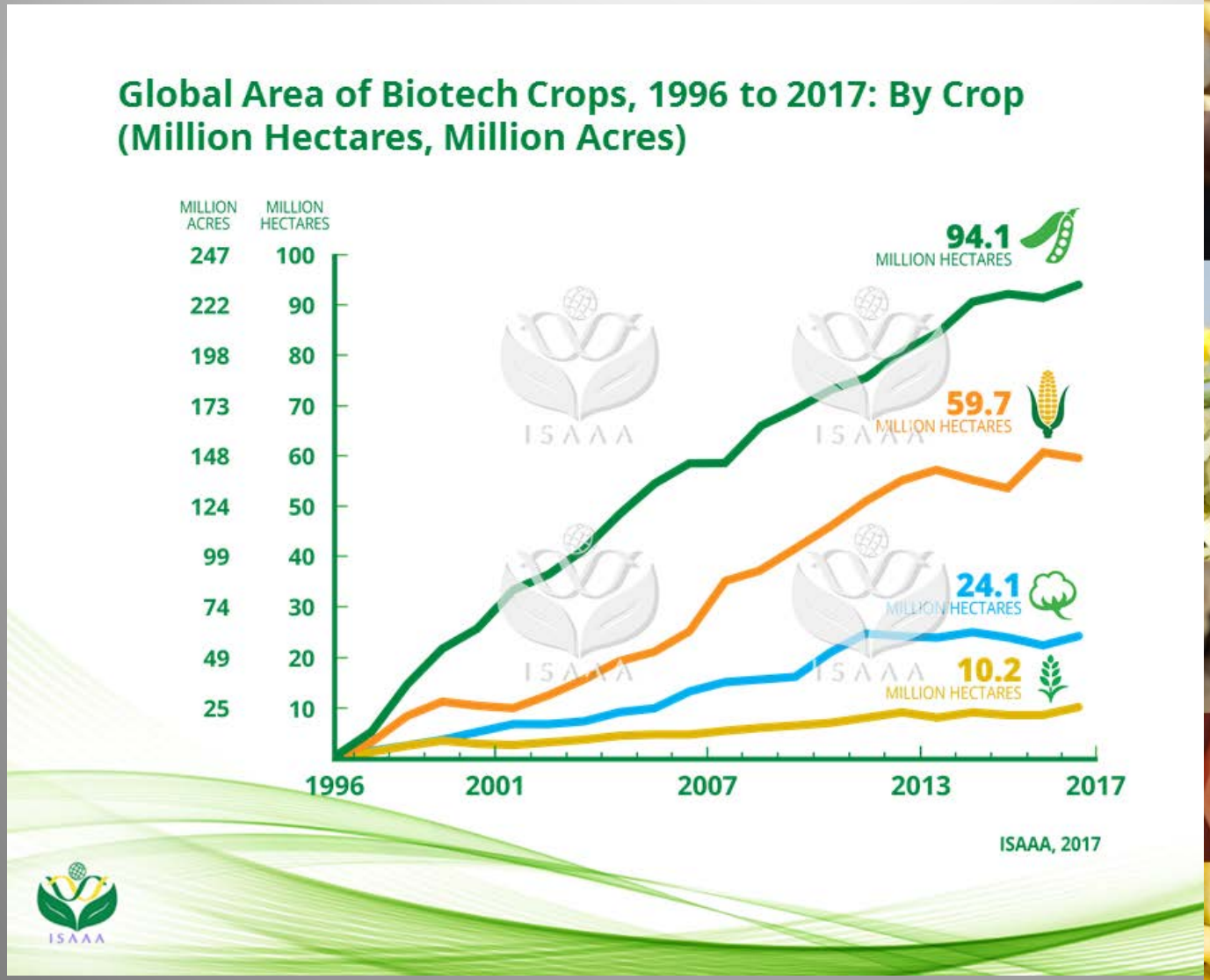


4. GE crops have provided great **value** to farmers and environment, and have been taken up at an extraordinary rate (where allowed)

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



Four crops dominate, 8+ in USA



Global “meta-analysis” of early impacts

“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%.”

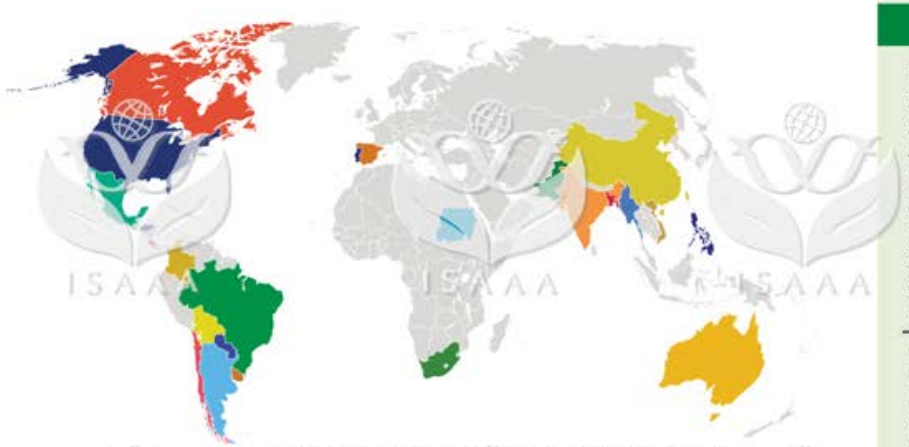
Herbicide tolerant plants promote conservation tillage – With many environmental benefits thereof

Conservation Technology Information Center

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

Adoption rates highly variable

Global Area of Biotech Crops, 2017: By Country (Million Hectares)



24 countries which have adopted biotech crops

3% Increase from 2016

In 2017, global area of biotech crops was 189.8 million hectares, representing an increase of 3% from 2016, equivalent to 4.7 million hectares.

Source: ISAAA, 2017.

50,000 hectares, or more	
1. USA	75.0 million
2. *Brazil**	50.2 million
3. *Argentina**	23.6 million
4. Canada	13.1 million
5. *India**	11.4 million
6. *Paraguay**	3.0 million
7. *Pakistan**	3.0 million
8. *China**	2.8 million
9. *South Africa**	2.7 million
10. *Bolivia**	1.3 million
11. *Uruguay**	1.1 million
12. Australia	0.9 million
13. *Philippines**	0.6 million
14. *Myanmar**	0.3 million
15. *Sudan**	0.2 million
16. Spain	0.1 million
17. *Mexico**	0.1 million
18. *Colombia**	0.1 million

Less than 50,000 hectares	
*Vietnam**	Portugal
*Honduras**	*Bangladesh**
*Chile**	*Costa Rica**

* *Developing countries*

5. Some GE crops and management practices are **not** a good idea, and very tough to manage

It is possible to transfer allergens with GE methods

The NEW ENGLAND JOURNAL of MEDICINE

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ORIGINAL ARTICLE

Identification of a Brazil-Nut Allergen in Transgenic Soybeans

Julie A. Nordlee, M.S., Steve L. Taylor, Ph.D., Jeffrey A. Townsend, B.S., Laurie A. Thomas, B.S., and Robert K. Bush, M.D.

N Engl J Med 1996; 334:688-692 | March 14, 1996

Abstract | Article | References | Citing Articles (201)

BACKGROUND

The nutritional quality of soybeans (*Glycine max*) is compromised by a relative deficiency of methionine in the protein fraction of the seeds. To improve the nutritional quality, methionine-rich 2S albumin from the Brazil nut (*Bertholletia excelsa*) has been introduced into transgenic soybeans. Since the Brazil nut is a known allergenic food, we assessed the allergenicity of the 2S albumin.

Full Text of Background...

MEDIA IN THIS ARTICLE

FIGURE 3

Reactivity on Skin-Prick Testing to Extracts of

Thus caution warranted

This product never developed for commercial use or marketed

Roundup tolerant bentgrass escape in Oregon

483

GMO grass that 'escaped' defies eradication, divides grass seed industry

8.1k
shares

http://www.oregonlive.com/business/index.ssf/2017/01/grass_seed_industry_fearful_ab.html

http://www.oregonlive.com/business/index.ssf/2017/01/post_248.html

Roundup tolerant bentgrass permitted

Feds deregulate controversial GMO grass seed

Linn County bills itself as the grass seed capital of the world. But the thriving grass business has been divided by a controversial genetically modified grass developed by Scotts Miracle-Gro. *(Jeff Manning/The Oregonian)*

By **Jeff Manning | The Oregonian/OregonLive**
Email the author | Follow on Twitter
on January 18, 2017 at 10:00 AM, updated January 18, 2017 at 10:18 AM

The U.S. Department of Agriculture on Tuesday deregulated a genetically modified grass that some Oregon farmers and dealers say threatens the state's grass seed business.

http://www.oregonlive.com/business/index.ssf/2017/01/grass_seed_industry_fearful_ab.html

http://www.oregonlive.com/business/index.ssf/2017/01/post_248.html

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.

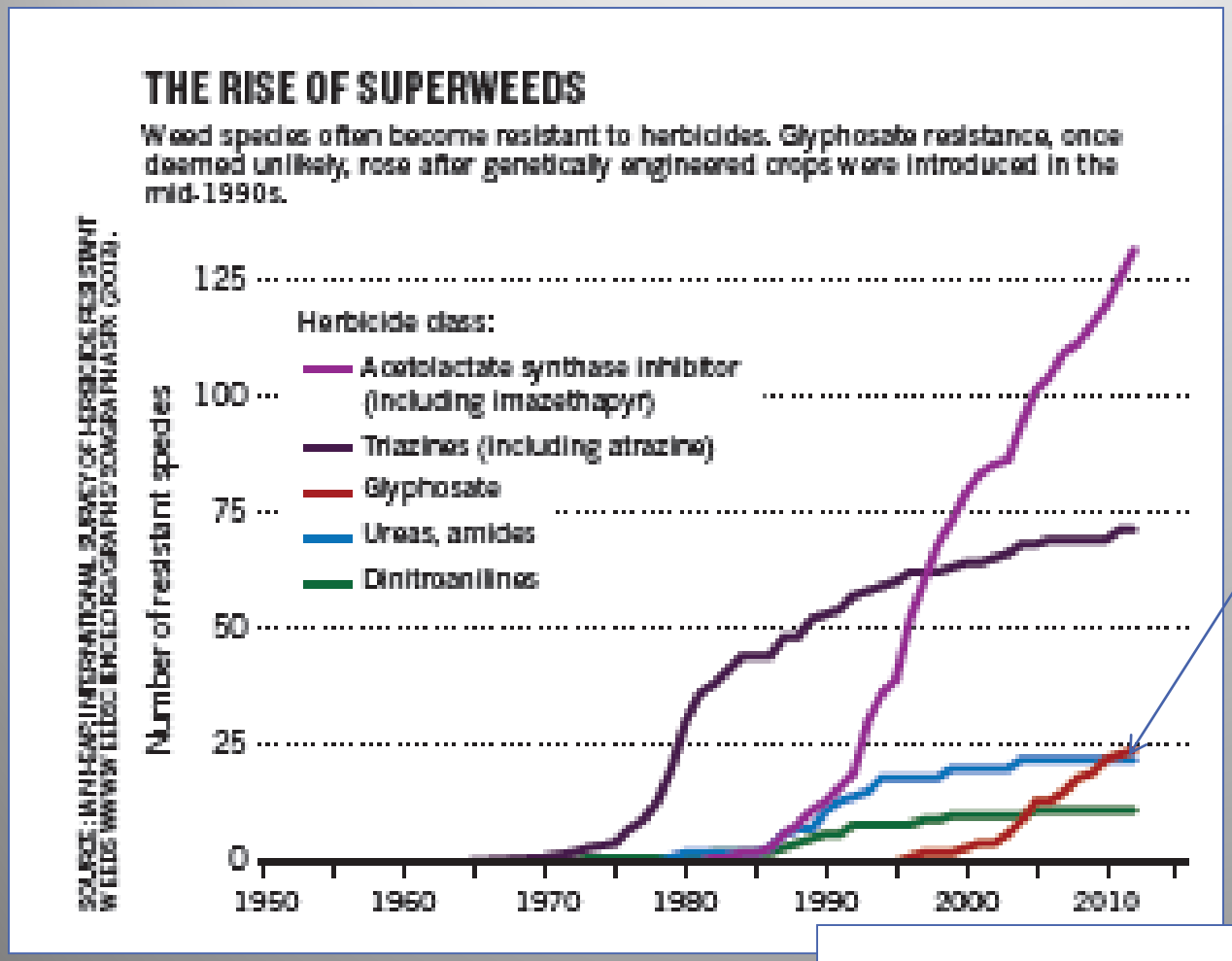
"The number of weed species evolving resistance to glyphosate

BILL BARKSDALE / AGSTOCKUSA /

The original clean fields – herbicide resistant cotton

Not an uncommon sight now

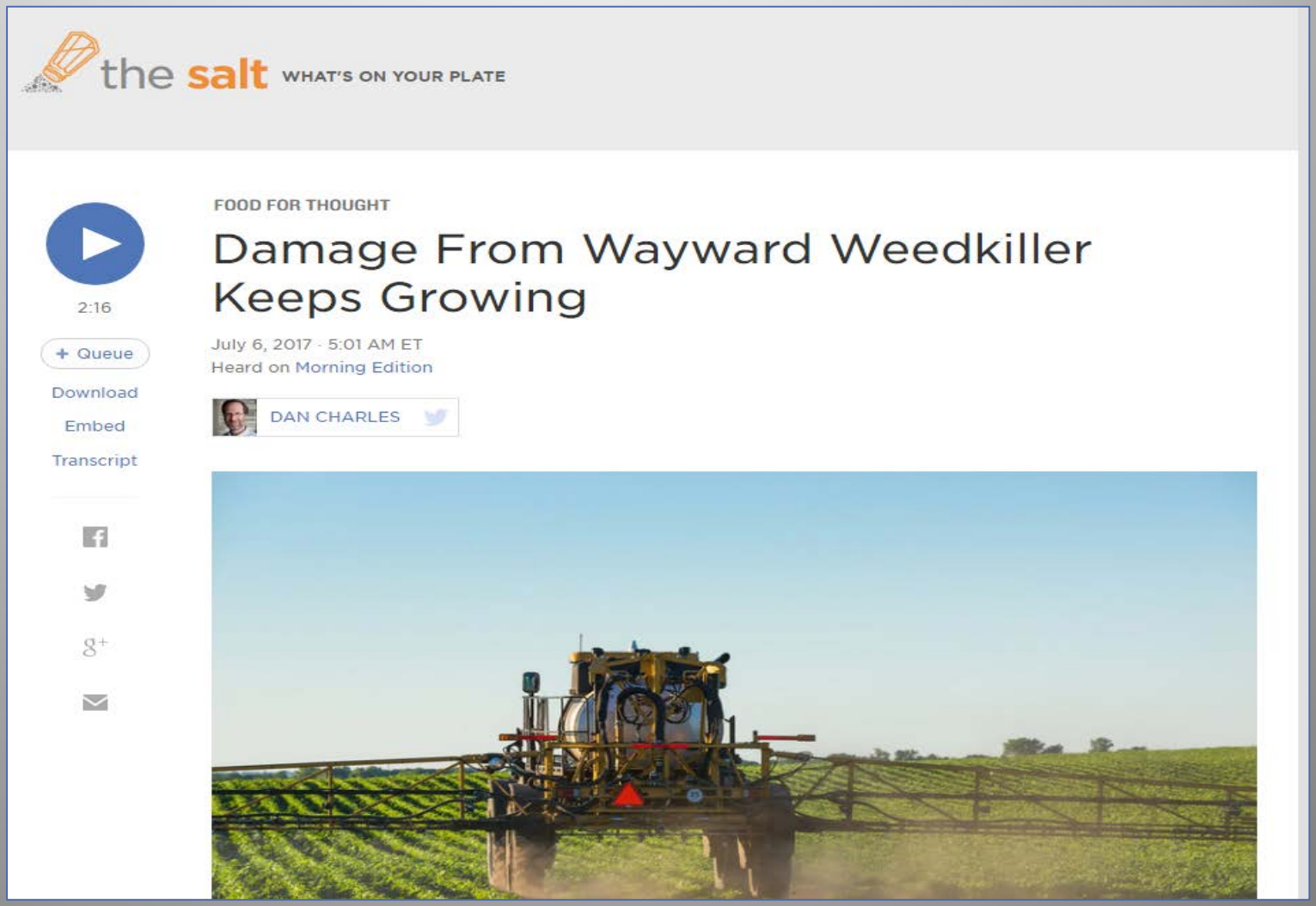
Herbicide-resistant weeds are an old problem in agriculture, but exacerbated by GE herbicide tolerant crops



Accelerated by GE Roundup-tolerant crops ?

24 | NATURE | VOL 497 | 2 MAY 2013

Damage from growing use of dicamba resistant crops – due to chemical's volatility



Insect resistance development

REVIEW

nature biotechnology

Surge in insect resistance to transgenic crops and prospects for sustainability

Bruce E Tabashnik & Yves Carrière

Transgenic crops have revolutionized insect pest control, but their effectiveness has been reduced by evolution of resistance in pests. We analyzed global monitoring data reported during the first two decades of transgenic crops, with each case representing the responses of one pest species in one country to one insecticidal protein from *Bacillus thuringiensis* (Bt). The cases of pest resistance to Bt crystalline (Cry) proteins produced by transgenic crops increased from 3 in 2005 to 16 in 2016. By contrast, in 17 other cases there was no decrease in pest susceptibility to Bt crops, including the recently introduced transgenic corn that produces a Bt vegetative insecticidal protein (Vip). Recessive inheritance of pest resistance has favored sustained susceptibility, but even when inheritance is not recessive, abundant refuges of non-Bt host plants have substantially delayed resistance. These insights may inform resistance management strategies to increase the durability of current and future transgenic crops.

VOLUME 35 NUMBER 10 OCTOBER 2017 NATURE BIOTECHNOLOGY

Insect resistance has risen in parallel with crop use

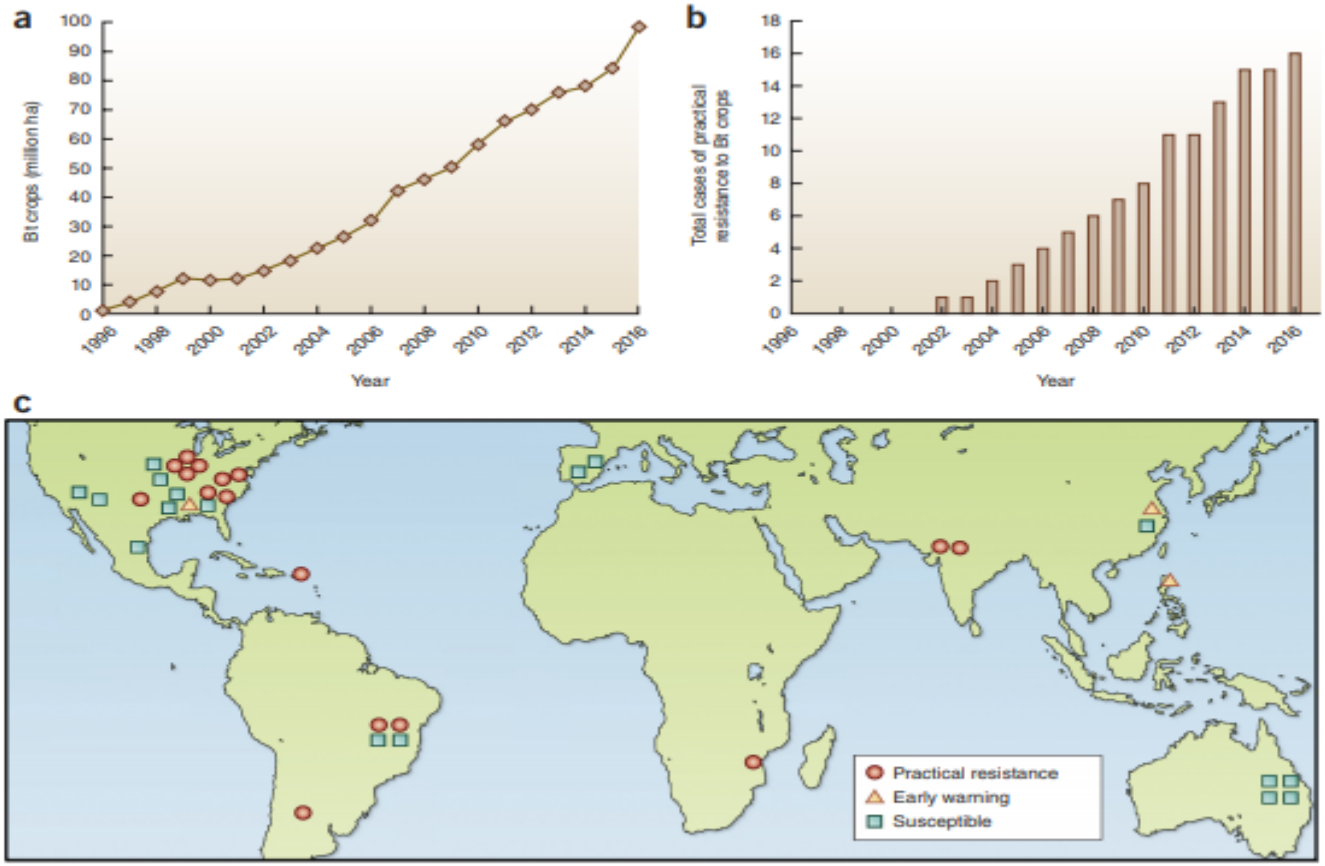


Figure 1 Global status of pest resistance to Bt crops. (**a**) Hectares planted to Bt crops each year. (**b**) Cumulative cases of field-evolved practical resistance to Bt crops. (**c**) Each symbol represents 1 of 36 cases indicating responses of one pest species in one country to one toxin in Bt corn, cotton, or soy (**Tables 1** and **2**).

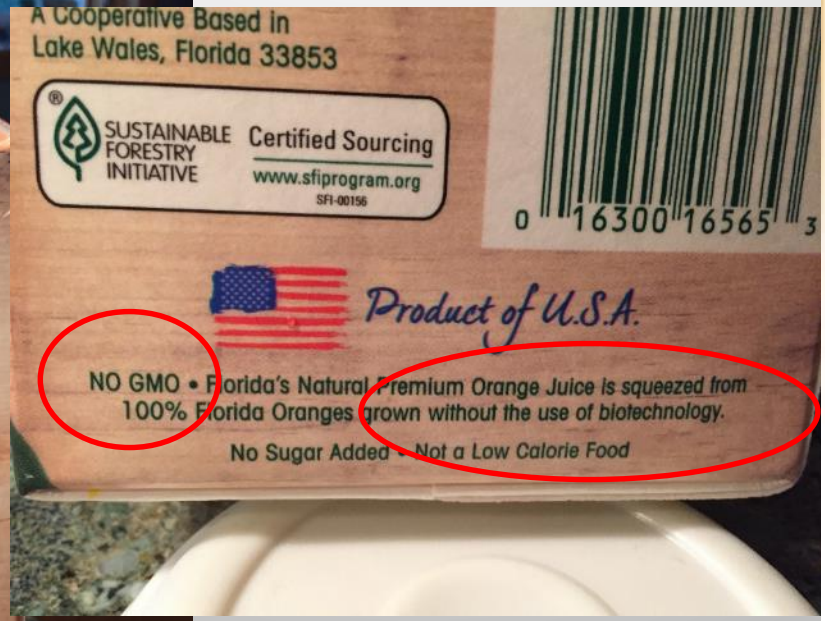
6. **Simple** answers to ag and food problems should set off alarm bells

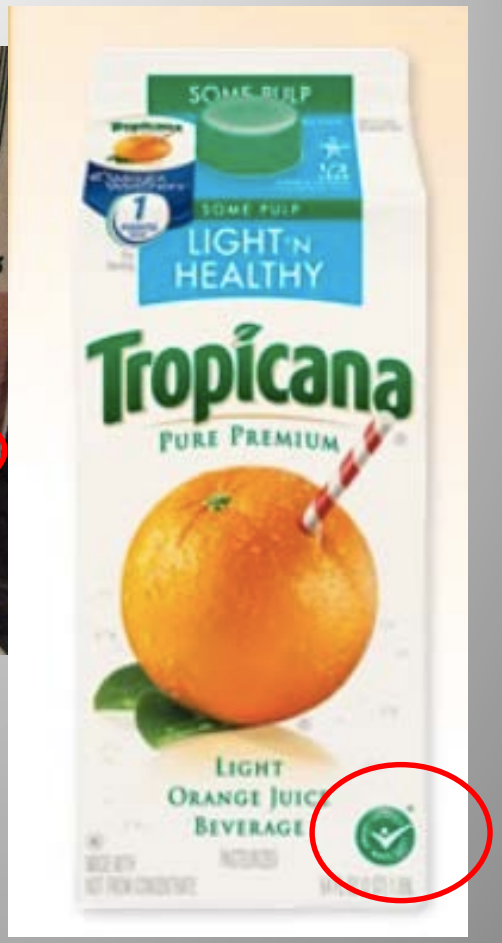
Non-GMO labels have proliferated

GMO-free labels a major feature of "clean label" movement

NON GMO Project
VERIFIED
nongmoproject.org

Non-GMO claims on orange juice





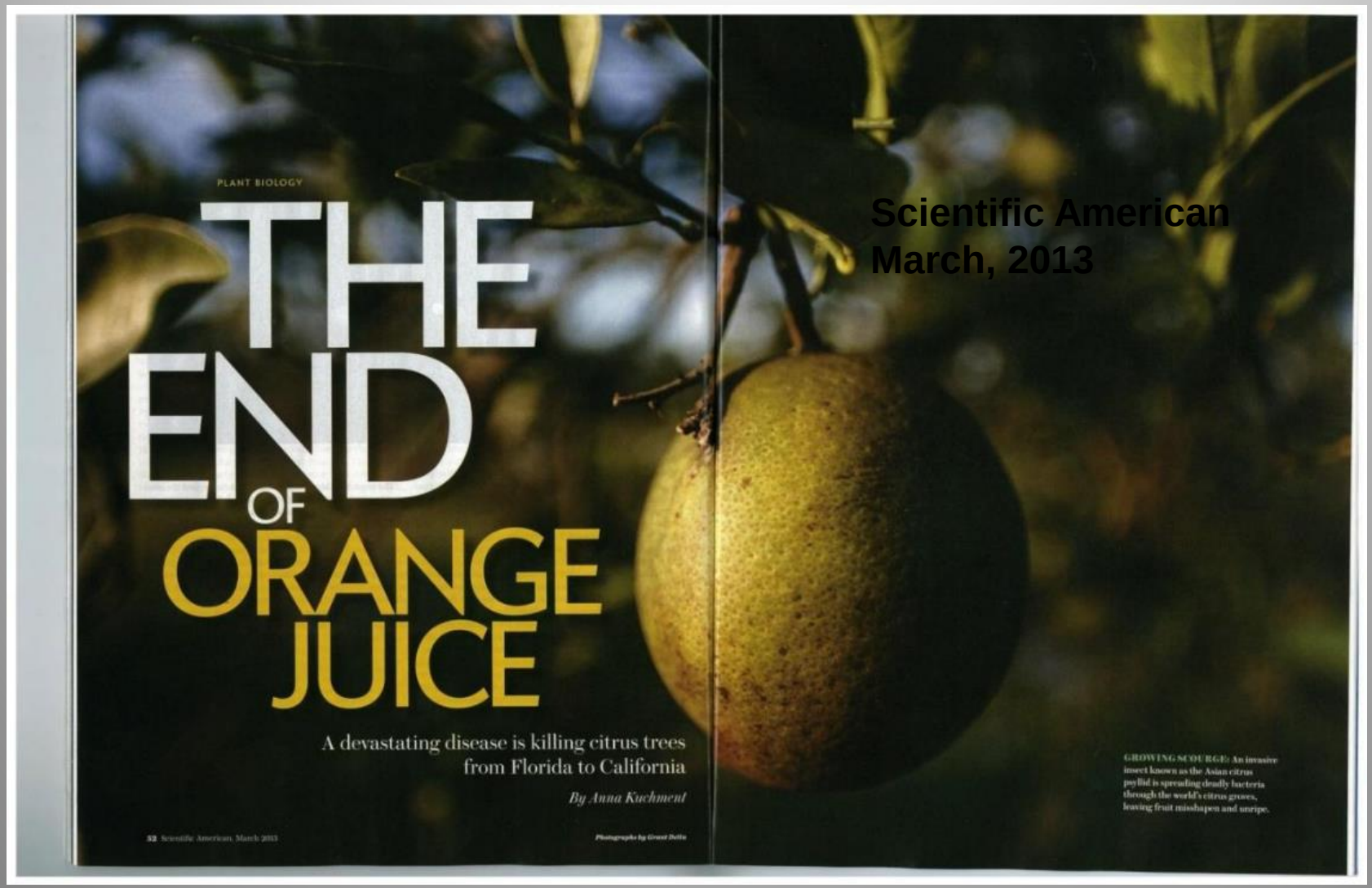
BUSINESS DAY

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 GE solutions to devastating ‘citrus greening’ threatening the industry



CRISPR-modified grapefruit resistant to citrus canker

Plant Biotechnology Journal

Plant Biotechnology Journal (2016), pp. 1–7 doi: 10.1111/pbi.12677

Genome editing of the disease susceptibility gene *CsLOB1* in citrus confers resistance to citrus canker

Hongge Jia[1], Yunzeng Zhang[1], Vladimir Orbović[2], Jin Xu[1], Frank F. White[3], Jeffrey B. Jones[3] and Nian Wang[1,*]

American chestnut was an iconic, widespread keystone forest tree in the USA

It was extirpated as a forest tree by Chestnut Blight

1912 photo of blight in NY

Complete destruction of chestnut trees in mixed stands. Note healthy condition of trees of other species. Views along Long Island Railroad, near Richmond Hill, New York.—*Photograph by Prof. Collins.*

Breeding has not worked despite nearly 100 years of effort – give genetic engineering a chance?

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Energy & Sustainability » Scientific American Volume 310, Issue 3 — 2 :: Email :: Print

The American Chestnut's Genetic Rebirth

A foreign fungus nearly wiped out North America's once vast chestnut forests. Genetic engineering can revive them

By William Powell

In 1876 Samuel B. Parsons received a shipment of chestnut seeds from Japan and decided to grow and sell the trees to orchards. Unbeknownst to him, his shipment likely harbored a stowaway that caused one of the greatest ecological disasters ever to befall eastern North America. The trees probably concealed spores of a pathogenic fungus, *Cryphonectria parasitica*, to which Asian chestnut trees—but not their American cousins—had evolved resistance. *C. parasitica* effectively strangles

More In This Article

A New Generation of American Chestnut Trees May Redefine America's Forests

Many other applications - Forest health a major and growing concern

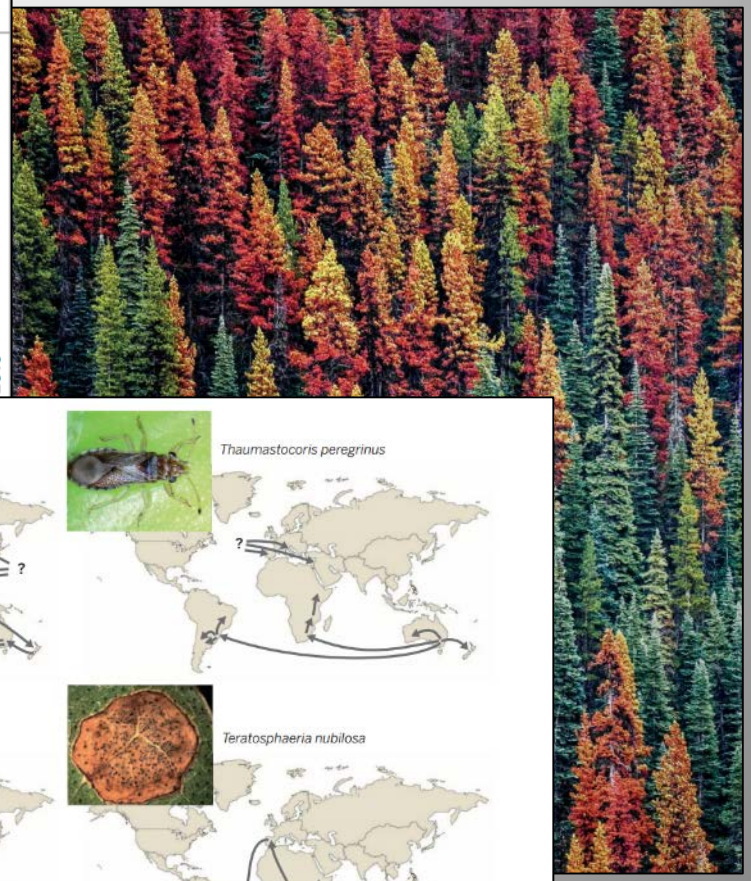
REVIEW

Planted forest health: The need for a global strategy

hoff,[2] B. D. Wingfield,[1] B. Slippers[1]

n planted forests worldwide, and these represent valuable
re increasingly threatened by insects and microbial
ccidentally and/or have adapted to new host trees.
st emergence, despite a growing awareness of the
of the costs, and an increased focus on the importance of
d potential of planted forests, innovative solutions and a
h are needed. Mitigation strategies that are effective only in
vasions elsewhere in the world, ultimately leading to global
roblems in the future should mainly focus on integrating
rather than single-country strategies. A global strategy to

2015



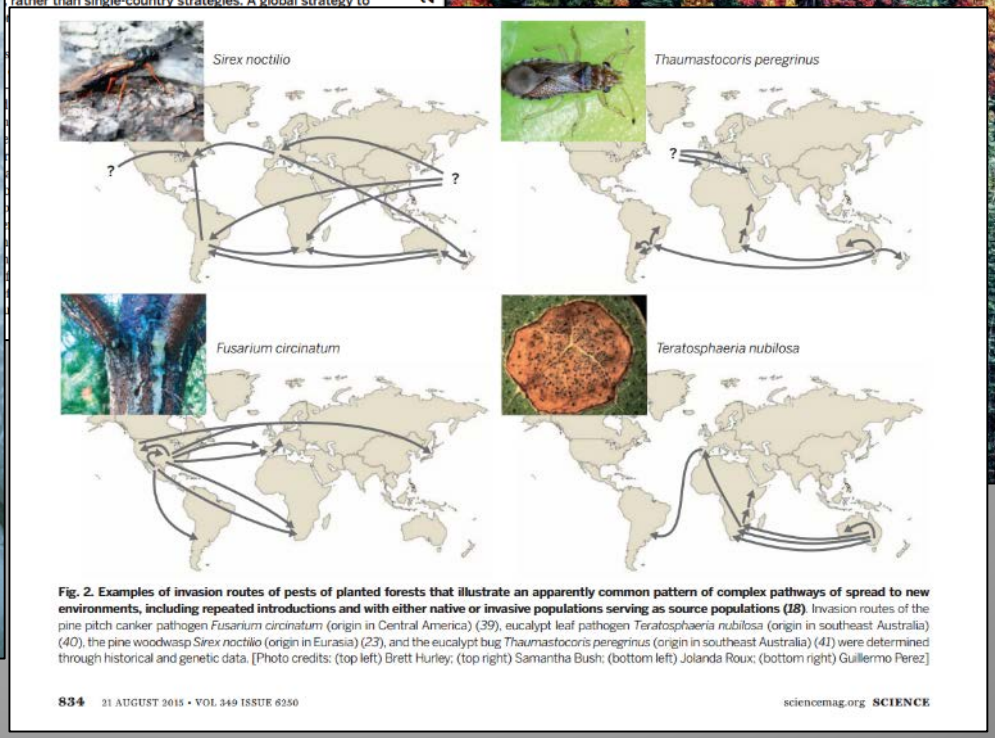


Fig. 2. Examples of invasion routes of pests of planted forests that illustrate an apparently common pattern of complex pathways of spread to new environments, including repeated introductions and with either native or invasive populations serving as source populations (*18*). Invasion routes of the pine pitch canker pathogen *Fusarium circinatum* (origin in Central America) (*39*), eucalypt leaf pathogen *Teratosphaeria nubilosa* (origin in southeast Australia) (*40*), the pine woodwasp *Sirex noctilio* (origin in Eurasia) (*23*), and the eucalypt bug *Thaumastocoris peregrinus* (origin in southeast Australia) (*41*) were determined through historical and genetic data. [Photo credits: (top left) Brett Hurley; (top right) Samantha Bush; (bottom left) Jolanda Roux; (bottom right) Guillermo Perez]

“Green” certification of forests create severe barriers to field research, markets

Plantation Certification & Genetic Engineering

FSC’s Ban on Research Is Counterproductive

Steven H. Strauss, Malcolm M. Campbell, Simon N. Pryor, Peter Coventry, and Jeff Burley

ABSTRACT

Genetic engineering, also called genetic modification (GM), is the isolation, recombinant modification, and asexual transfer of genes. It has been banned in forest plantations certified by the Forest Stewardship Council (FSC) regardless of the source of genes, traits imparted, or whether for research or commercial use. We review the methods and goals of tree genetic engineering research and argue that FSC’s ban on research is counterproductive because it makes it difficult for certified companies to participate in the field research needed to assess the value and biosafety of GM trees. Genetic modification could be important for translating new discoveries about tree genomes into improved growth, quality, sustainability, and pest resistance.

Keywords: biotechnology; entomology and pathology; ethics; genetics; silviculture

Genetic engineering, commonly called genetic modification (GM) in much of the world, is the use of recombinant DNA and asexual gene transfer methods to breed more productive or pest-resistant crops. It has been the subject of considerable controversy, with concerns raised from biological, socioeconomic, political, and ethical perspectives. Some of the issues are similar to those raised by the use of molecular biology and genetic engineering in medicine, which we see in the news headlines daily. However, genetic modification in agriculture and forestry raises environmental issues as well.

GM crops, mainly herbicide- and pest-resistant varieties of soybeans, maize, or cotton, have been vigorously adopted by farmers in North America because they are easy to manage and they improve yields, reduce costs, or reduce pesticide ecotoxicity (Carpenter and Gianessi 2001). However, the controversy, primarily embodied in regulatory barriers to trade of GM crops with Europe and Japan, has slowed their adoption considerably in recent years.

If GM trees are used in forestry in the near future, they are likely to occur primarily in intensively managed environments, such as urban forests or plantations. In urban forestry, genetic modification is expected to help trees adapt to the stresses and special demands of human-dominated systems. Examples would be trees that are more tolerant of heavy metals or other pollutants, resist urban pests or diseases, grow slower, or do not produce fruits when these create hazards in street environments (Brunner et al. 1998).

Plantations, although very different from natural forests in structure and function, are considered part of the spectrum of methods in sustainable forest management (Romm 1994). Plantations can relieve pressure on natural forests for exploitation and can be of great social value by supplying community and industrial wood needs and fueling economic development. The environmental role of plantations is recognized by the Forest Stewardship Council (FSC), an international body for certification of sustainably managed forests. FSC Principle 10 states that plantations should “complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests” (FSC 2001).

FSC has certified some of the most intensively managed plantations in the world, including poplar plantations and the intensive pine and eucalypt plantations of the Southern Hemisphere. Although many environmental mitigations are built into these certified plantation systems, within the areas dedicated to wood production they function as tree farms. Such intensive plantation systems often use highly bred genotypes, possibly including exotic species, hybrids, and clones, as well as many other forms of intensive silvicultural management. It is in the context of these biointensive systems that the additional expense of GM trees is likely to be worthwhile.

However, FSC currently prohibits all uses of GM trees, and is the only certification system to have done so

Forest Stewardship Council

“…genetically modified trees are prohibited…”

7. There is a **vast variety** of GE products shown in research, but only two kinds have dominated due to economic and regulatory/market obstacles

And with rare exceptions, as a result only **big ag** can play

Virus-resistant GM papaya

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

Like a vaccine – "**RNAi immunization**" via implanting a viral gene in the papaya genome

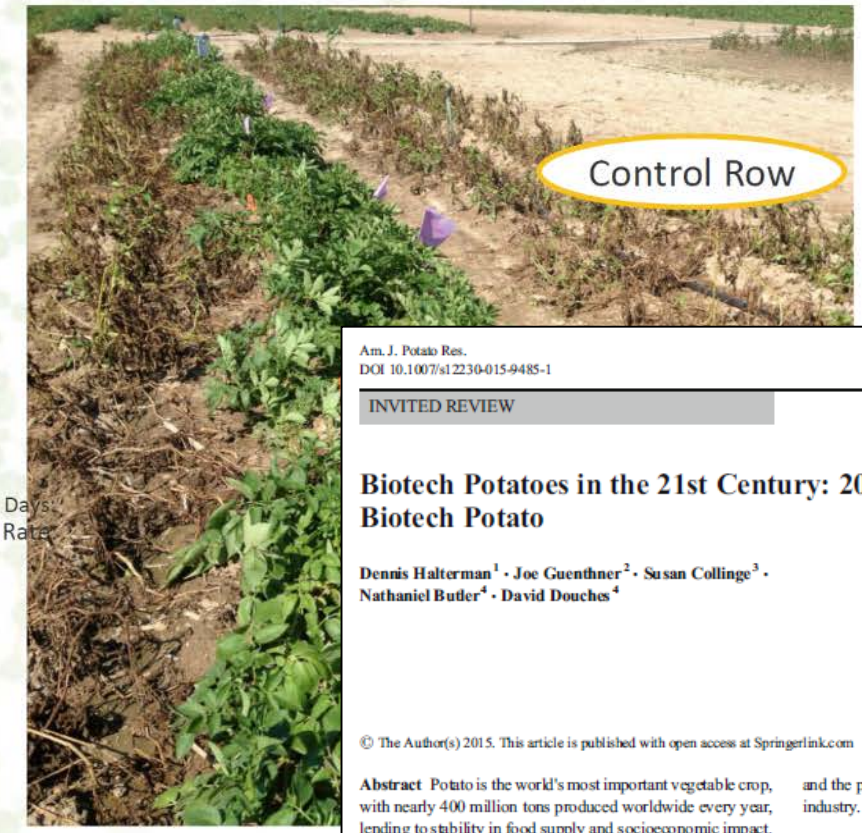
“Innate” potato – native DNA, non-browning and other traits

One hour after cutting – Control vs. Innate

Two days after cutting – Control vs. Innate

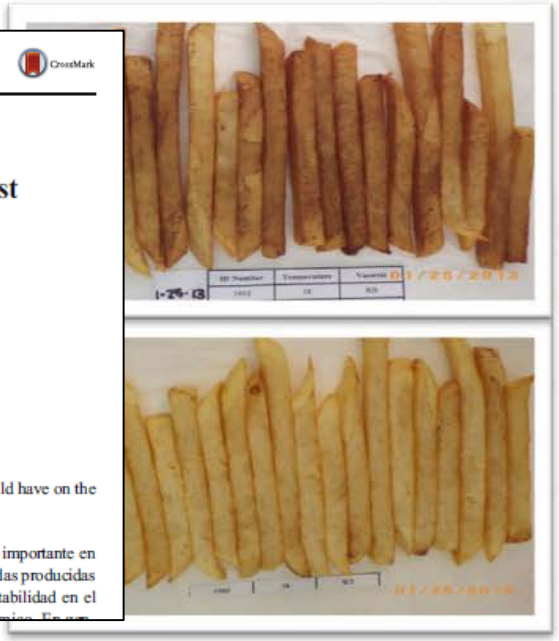
“Innate 2.0” potato – late blight resistant, and reduced sprouting and browning (↓ waste, ↑ safety, ↓ pesticide, ↑ yield)

Midwest - Sept 4th 2013



Control | Innate™ 2.0

Zebra Chip



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

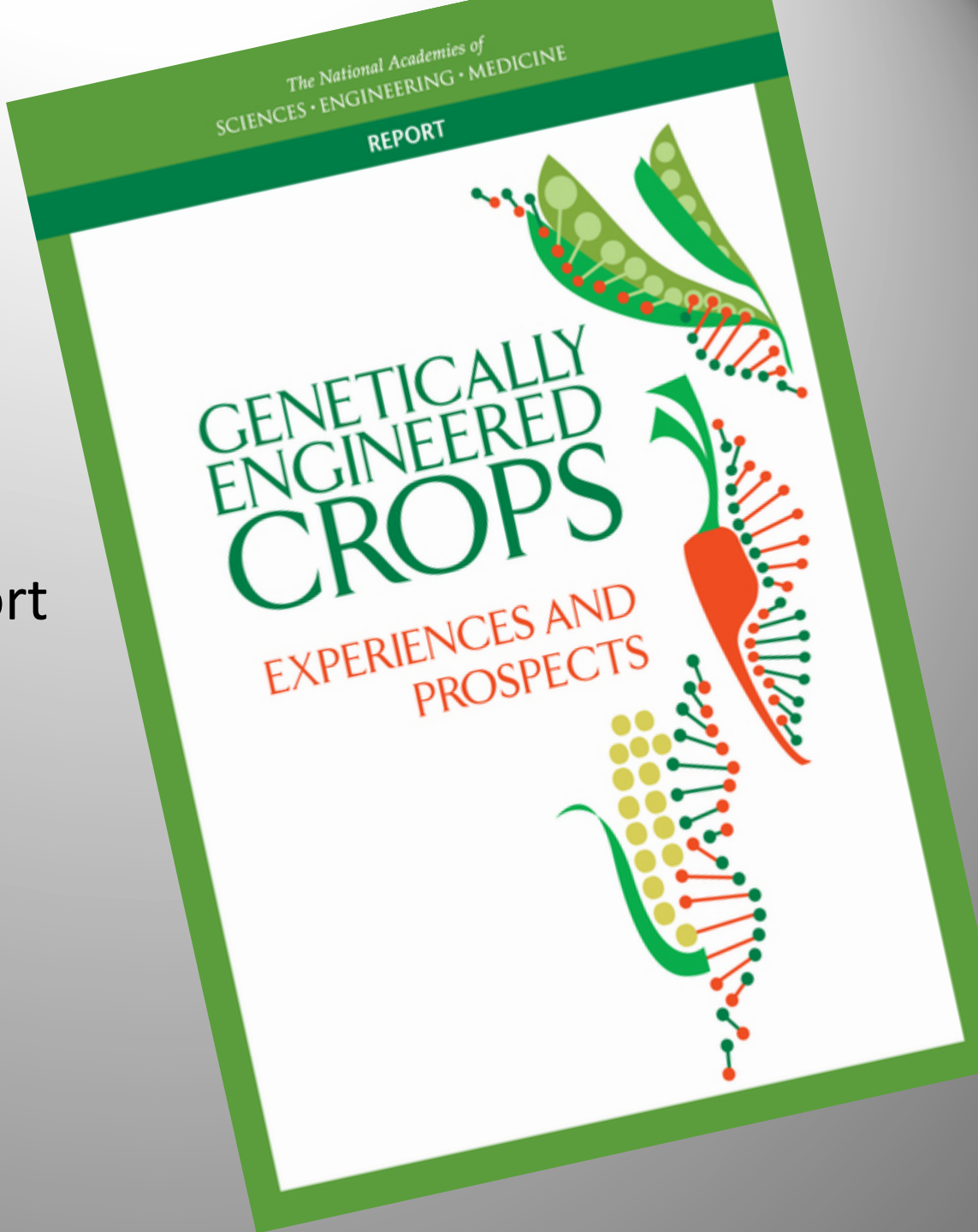
Diverse pipeline of biofortification products = enhancement of critical vitamins or nutrients

Golden Rice creator Ingo Potrykus

8. There is no credible scientific evidence GE foods **have had any harms** to humans or animals

National Research Council Report 2016

- No evidence to support food/feed safety concerns
- Confirmed large insecticide reduction with Bt crops



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
version 2
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 science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."
The premier body of physicians in the United States
"There is no scientific justification for special labeling of genetically modified foods.
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 World Health Organization (WHO) is the directing and coordinating authority for health within the United Nations system.
"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.
The National Academy of Sciences is a non-profit organization in the United States. It is the premier scientific body in the United States
"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 have been identified"
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
"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
The European Commission (EC) is the executive body of the European Union
"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

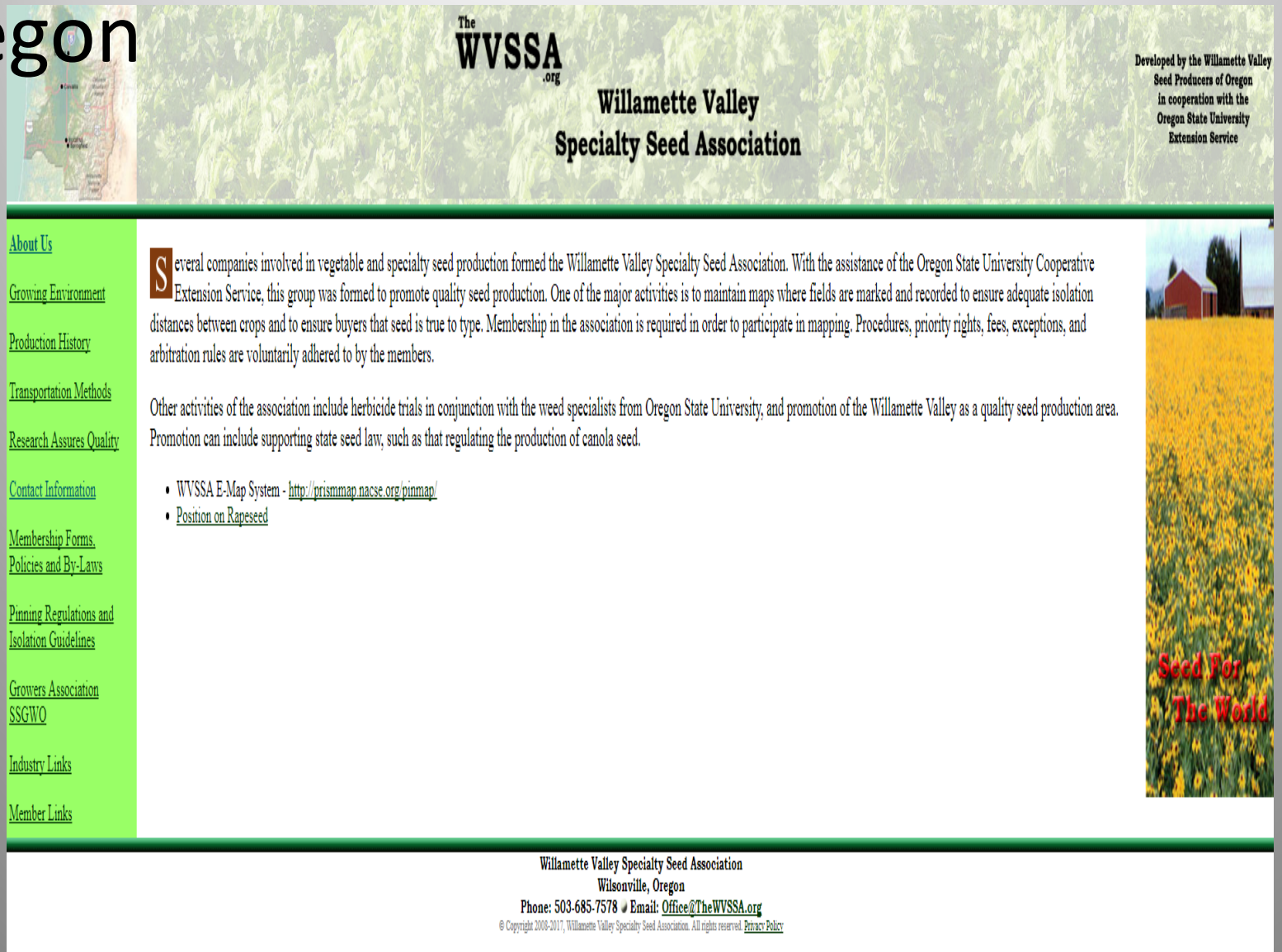
http://www.axismundionline.com/blog/the-new-is-gm-food-safe-meme/

9. Gene flow is normal in agriculture, well managed by private sector – need to develop workable thresholds in regulations and markets

Gene flow: Genetic admixture is ubiquitous in agriculture – with or without GMOs

Genes that cause a color change make it possible to easily see what is the norm in many types of agriculture

Local example of private association for gene flow mitigation among farmers in Oregon



The WVSSA.org

Willamette Valley Specialty Seed Association

Developed by the Willamette Valley Seed Producers of Oregon in cooperation with the Oregon State University Extension Service

About Us

Growing Environment

Production History

Transportation Methods

Research Assures Quality

Contact Information

Membership Forms, Policies and By-Laws

Pinning Regulations and Isolation Guidelines

Growers Association SSGWO

Industry Links

Member Links

Several companies involved in vegetable and specialty seed production formed the Willamette Valley Specialty Seed Association. With the assistance of the Oregon State University Cooperative Extension Service, this group was formed to promote quality seed production. One of the major activities is to maintain maps where fields are marked and recorded to ensure adequate isolation distances between crops and to ensure buyers that seed is true to type. Membership in the association is required in order to participate in mapping. Procedures, priority rights, fees, exceptions, and arbitration rules are voluntarily adhered to by the members.

Other activities of the association include herbicide trials in conjunction with the weed specialists from Oregon State University, and promotion of the Willamette Valley as a quality seed production area. Promotion can include supporting state seed law, such as that regulating the production of canola seed.

- WVSSA E-Map System - http://prismmap.nacse.org/pinmap/
- Position on Rapeseed

Willamette Valley Specialty Seed Association
Wilsonville, Oregon
Phone: 503-685-7578 ◦ Email: Office@TheWVSSA.org

Oregon bill to punish for GMO admixture – not passed

79th OREGON LEGISLATIVE ASSEMBLY--2017 Regular Session

House Bill 2739

Sponsored by Representative BARNHART (at the request of Sandra Bishop)

SUMMARY

The following summary is not prepared by the sponsors of the measure and is not a part of the body thereof subject to consideration by the Legislative Assembly. It is an editor's brief statement of the essential features of the measure **as introduced.**

Allows cause of action against patent holder for genetically engineered organism present on land without permission of owner or lawful occupant. Allows court to award prevailing plaintiff costs, attorney fees and treble economic damages.

A BILL FOR AN ACT

Relating to patent holder liability for genetically engineered organisms.

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

Billions of dollars 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

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

Lawsuits against farmers for innocent contamination due to gene flow?

Organic growers/seed distributors (OSGATA) conceded that Monsanto had never threatened to sue them.

https://www.geneticliteracyproject.org/2016/01/04/gmo-patent-controversy-3-monsanto-sue-farmers-inadvertent-gmo-contamination/

10. Vilification of GE is a tool for unscrupulous or uncompetitive companies, countries, and NGOs

Non-GMO labels have proliferated

Very well funded activism against GMOs and related ag/food issues

- Agbiotech Info Net
- Agribusiness Examiner
- ACGA
- American Pasturage
- APHA
- Animal Protection Institute
- Beyond Pesticides
- NCRLC
- **Center for Food Safety**
- Center for Informed Food Choices
- Center for Media & Democracy
- Chef's Collaborative
- Children's Health Env Coalition
- Common Dreams
- Consumer Federation of America
- **Consumers Union**
- Crop Choice
- David Suzuki Foundation
- Dawn Watch
- Deep Ecology
- Eco-Trust
- Economic Democracy
- Earth Spirit
- Farm Animal Reform Movement
- Farm Aid
- Farm Sanctuary
- **Friends of the Earth**
- GRACE
- Government Accountability Project
- Green Guide Institute
- Green Party USA
- **Greenpeace**
- Humane Farm Association
- Humane Society US
- IATP
- Institute for Public Accuracy
- Land Institute
- Local Harvest
- NFFC
- Nishoren
- No Spray coalition
- NWARN
- **Organic Consumers Association**
- PANNA

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

Leading scientists attack Greenpeace over anti-GMO activism

Speaking of Science

107 Nobel laureates sign letter blasting Greenpeace over GMOs

The Washington Post
Democracy Dies in Darkness

By Joel Achenbach June 30, 2016

Ten statements about biotech/GMOs

1. Complex, controversial
2. It's a method not a product
3. "Radical" non-GMO crop breeding
4. Rapid GMO uptake and large benefits
5. GMO problems and challenges
6. Simple answers and labels
7. Diversity of potential products
8. Approved GMO foods are safe
9. Gene flow and contamination myths
10. GMO vilification for profit in labels and beyond

Some lessons

- GE a general technology – many potential uses
- Newer methods more precise, powerful (CRISPR)
- No credible evidence for human or animal safety harms
- Extensive uptake, large benefits, but also significant problems in management
- Regulatory and market restrictions greatly limit GE crop use and benefit for society, both in USA and around the globe – despite stresses from climate change, pest proliferation, and growing human need
- Need major regulatory and marketing reforms for smarter and expanded use, alignment with science