Navigating the Controversies over GMO Crops

The good, the bad, and the righteous

Steve Strauss

Oregon State University

Why is this so controversial?

- Powerful science – broader gene pool, more efficient, local and global need pressing

- Large corporations – Monsanto effect
- New and strong patents – gene movement in environment

- Industrial agriculture concerns/opposition
  - Herbicide and pesticide use / treadmill
- Environmentalist-local-organic-natural food and health movements – ideologically against all of the above
  - Strong financial motive to oppose-stigmatize-label-ban

- Governments and regulatory regimes in the middle – how to control-regulate-consider given polarization, issues?

Roadmap for talk

- **A bit about me**
- Orientation
  - The context, definition of GE
- The good, bad, and the righteous
  - Good: Status in world, a few examples, humanitarian promise
  - Bad: Mismanagement, regulation/trade
  - Righteous: A la Jonathan Haidt – "Moral certainty" that polarize and impede collaborative solutions

Research: Genetics and genetic engineering of poplars

Outreach: Former Director, OSU Outreach in Biotechnology program for 8 years

20 years of experience in management of field trials

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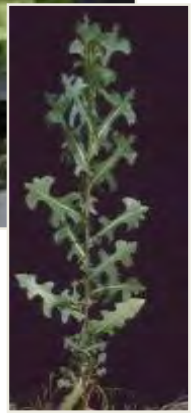
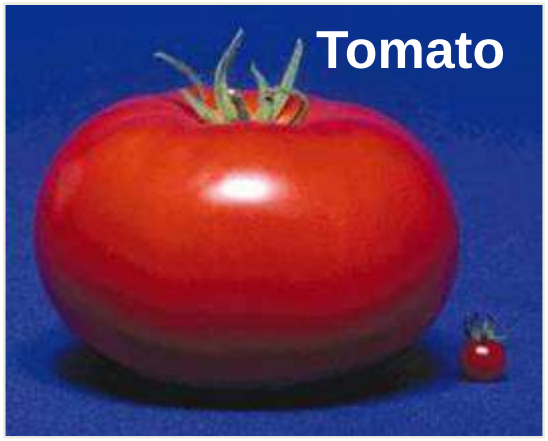
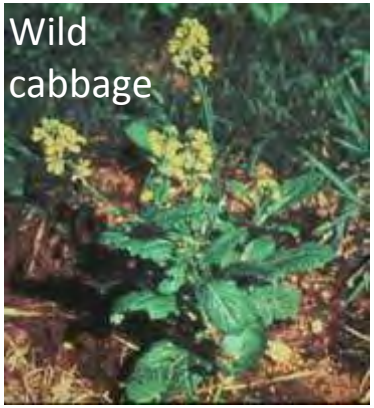
Aren’t most food crops already genetically engineered?





Mutants are some of our best friends:

Domestication of *Brassica oleracia*



Kohlrabi
Germany, 100 AD

Ornamental kale
Late 1900's

Kale, 500 BC

Brussel sprouts
Belgium, 1700's

Many plant varieties derived from induced mutations

Over 2,000 crop varieties derived from mutagenesis have been commercialized

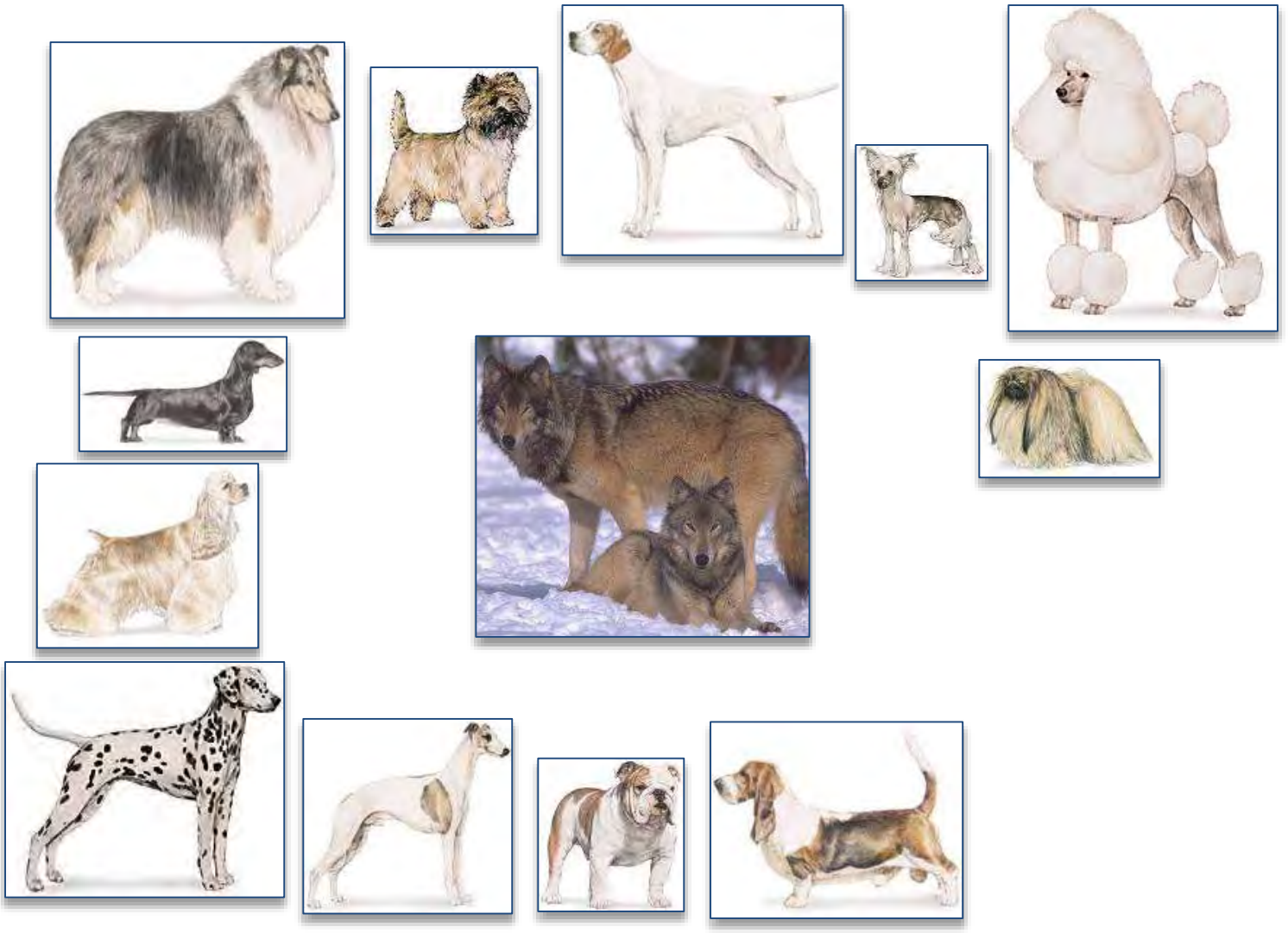
Calrose 76 semi-dwarf rice

High oleic sunflower

Rio Red grapefruit

Radical changes in domesticated animals:

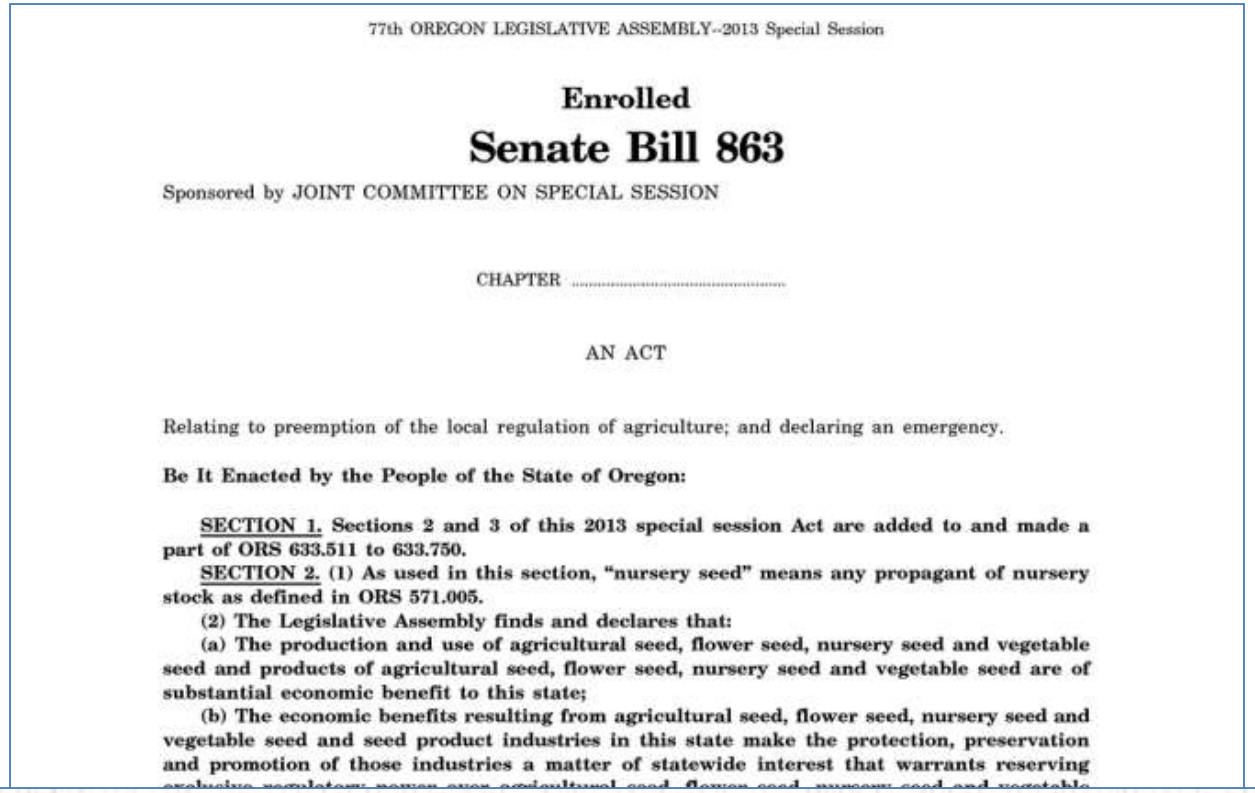
All dogs derived from the wolf by breeding



Breeding continues and is accelerating in age of massive DNA sequencing

Yet GMOs, and only GMOs, have remained powerfully controversial for ~two decades

Recently passed Oregon bill motivated by anti-GMO activism at county level



77th OREGON LEGISLATIVE ASSEMBLY--2013 Special Session

Enrolled

Senate Bill 863

Sponsored by JOINT COMMITTEE ON SPECIAL SESSION

CHAPTER .....

AN ACT

Relating to preemption of the local regulation of agriculture; and declaring an emergency.

Be It Enacted by the People of the State of Oregon:

SECTION 1. Sections 2 and 3 of this 2013 special session Act are added to and made a part of ORS 633.511 to 633.750.

SECTION 2. (1) As used in this section, "nursery seed" means any propagant of nursery stock as defined in ORS 571.005.

(2) The Legislative Assembly finds and declares that:

(a) The production and use of agricultural seed, flower seed, nursery seed and vegetable seed and products of agricultural seed, flower seed, nursery seed and vegetable seed are of substantial economic benefit to this state;

(b) The economic benefits resulting from agricultural seed, flower seed, nursery seed and vegetable seed and seed product industries in this state make the protection, preservation and promotion of those industries a matter of statewide interest that warrants reserving

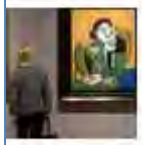
(c) The agricultural seed, flower seed, nursery seed and vegetable seed and seed product industries in this state will be adversely affected if those industries are subject to a patchwork of local regulations.

Jackson County, Oregon GMO ban - on ballot this month

Proposed GMO crop ban in Jackson County attracts opposing farm interests from around country

Vermont labeling law passed

The New York Times



DEALBOOK
Sotheby's and Loeb End Fight Over Board

Europe Expects Its Economy to Grow 1.6% This Year

China Tightens Rules for Foreign-Made Milk Powders

Pfizer Profit Tumbles 1

BUSINESS DAY

Vermont Will Require Labeling of Genetically Altered Foods

By STEPHANIE STROM APRIL 23, 2014

EMAIL
FACEBOOK
TWITTER
SAVE
MORE

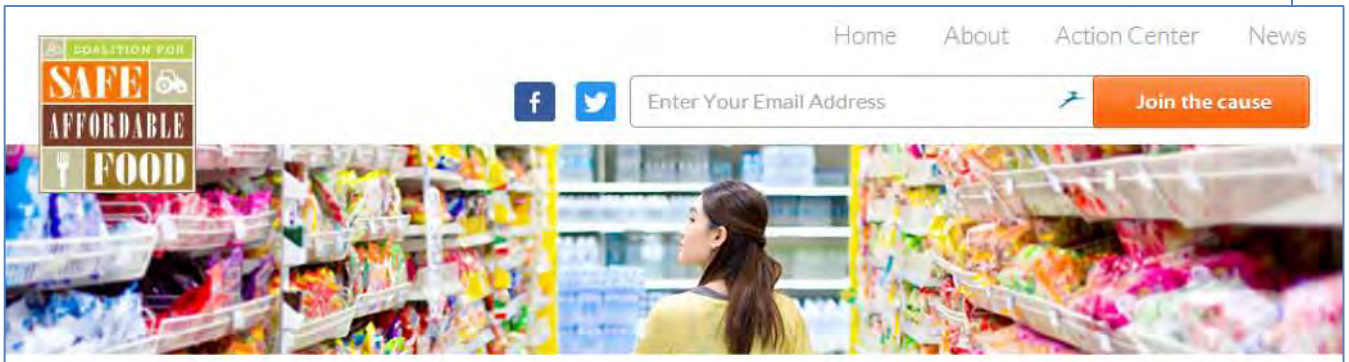
Going further than any state so far, Vermont on Wednesday passed a law requiring the labeling of foods that contain genetically engineered ingredients.

Though the move came in a tiny state far from the nation's population centers, proponents of such labeling immediately hailed the legislative approval as a significant victory. Labeling efforts are underway in some 20 other states, and the biotech and food industries have been pushing for federal legislation that would pre-empt such action.

Effort underway to standardize and prohibit Balkanization of GE regulations throughout USA

- American Bakers Association
- American Beverage Association
- American Farm Bureau Federation
- American Feed Industry Association
- American Frozen Food Institute
- American Seed Trade Association
- American Soybean Association
- American Sugarbeet Growers…….

AND 20 MORE



Broad-Based Coalition Launched to Advocate for Congressional Action on a Federal GMO Labeling Solution

February 5, 2014

Broad-Based Coalition Launched to Advocate for Congressional Action on a Federal GMO Labeling Solution

Legislation Needed to Protect Consumers by Eliminating Confusion and Advancing Food Safety

(Washington, D.C.) American farmers and representatives from a diverse group of almost thirty industry and non-governmental organizations today announced the formation of the Coalition for Safe Affordable Food (www.CFSAF.org) and urged Congress to quickly seek a federal solution that would establish standards for the safety and labeling of food and beverage products made with genetically modified ingredients (GMOs).

Views are polarized

US public opinion divided over biotechnology?

Although a majority of US citizens remain supportive, opposition to biotechnology is on the rise.

Susanna Hornig Priest

Conventional wisdom judges the people of the United States to have few concerns about biotechnology in comparison to people in other parts of the developed world. According to data from a new survey, this picture is at once both accurate and misleading. At least one other major comparative study using data from 1996–1997 published this year appeared to indicate generally more favorable attitudes in the US than in Europe[1]. But recent data reflect mixed opinions in the US consistent with other evidence suggesting moderate declines in US support. While the proportions may be different, the US increasingly resembles Europe in having significant amounts of opposition.

A changing climate

Several reports have suggested that the concern does not reach the levels of positive responses obtained in this survey for similar questions about other technologies ranging from computers and information technology (with 87.8% expecting improvement), to solar energy (87.7%), telecommunications (82.3%), the Internet (72.1%), and even space exploration (62.2%). Of the technologies included in this study, only nuclear energy (with just 43.0% expecting it to improve life) scored lower. And of all seven technologies, only nuclear energy (with 32.4% expecting it to "make things worse") was similar to genetic engineering in garnering close to one-third negative responses. In other words, despite different levels of overall support, the two technologies are very similar in the proportion of people who hold the more pessimistic view. The conventional wisdom that says that genetic engineering is non-controversial in the US is difficult to sustain in the light of these figures, as is the assumption that opposition is limited to the extremist "fringe."

greater than benefit rose from 20% in 1995 to 24% in 1997 to 29% in 1999[3]. Other indicators suggest US opinion has grown increasingly negative. According to figures released by the US Office of Technology Assessment, in 1986 only 22% of the US public thought genetic engineering would make "the quality of life" worse, and in 1982 only 16%[4].

In this context, the Public Policy Research Institute at Texas A&M University conducted a telephone survey for the author between April 10 and May 3 that explored current public attitudes to biotechnology. The nationwide survey was limited to US citizens aged 18 and over, and was based on standard random digit dialing procedures, resulting in 1002 completed interviews out of 3182 qualified contacts (a cooperation rate of 31.5%).

Susanna Hornig Priest is associate professor in the Department of Journalism, Texas A&M University, College Station TX 77843-4111 (susanna@tamu.edu).

Broad views predict acceptance-rejection

THE CONVERSATION

Home Business + Economy Environment + Energy Health + Medicine Politics + Society Science + Technology Election 2013

9 October 2013, 2.26pm AEST

How values affect our attitudes to genetically modified food

Craig Cormick

As Rod Lamberts reminded us here recently, when it comes to debates on genetically

CSIRO

Australia - October 2013

Broad attitudes towards science, technology and nature influence consumer attitudes towards GM foods

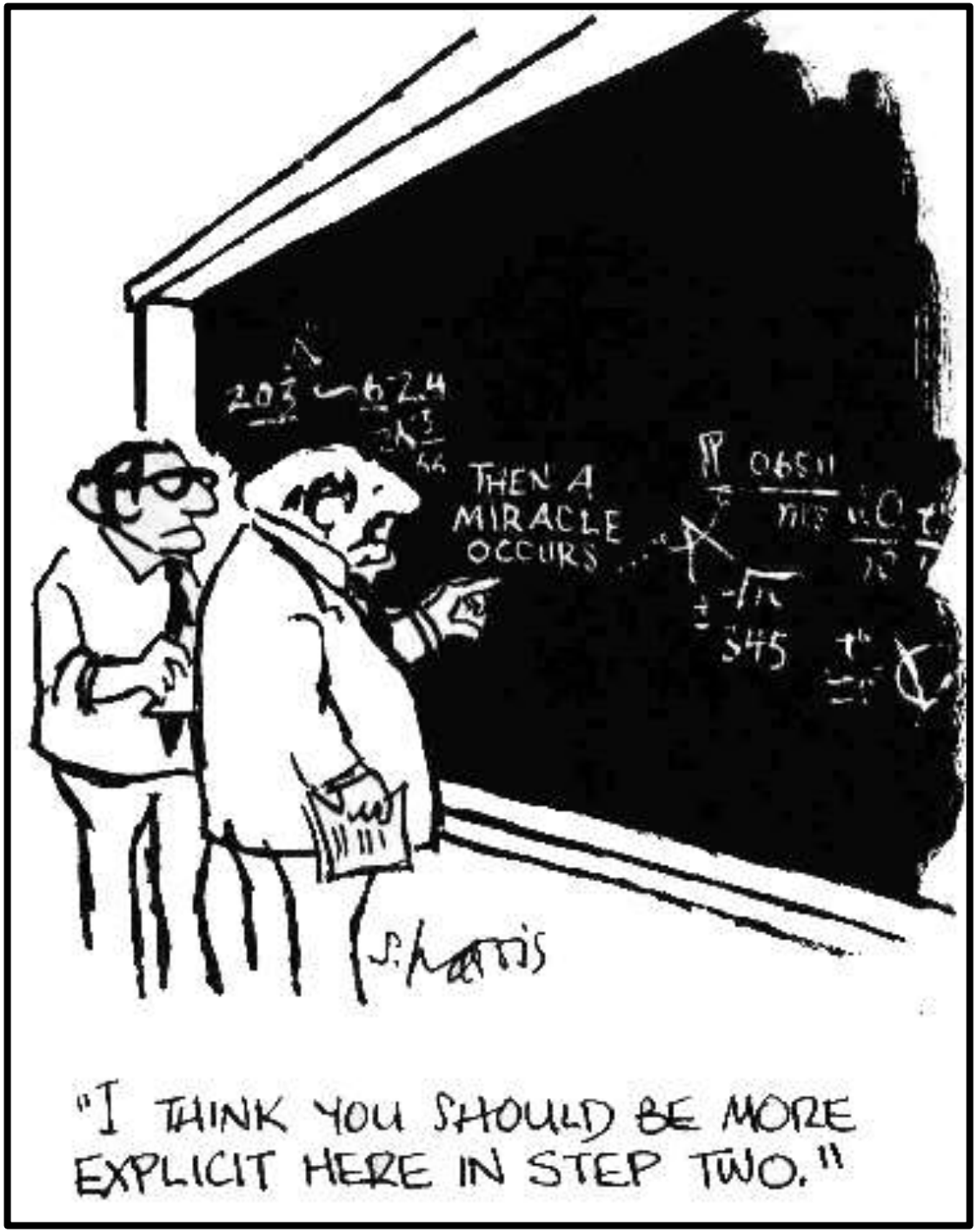
Pro-science and technology values are a strong predictor of support for GM foods

Not just polarized, but entrenched and tribalized

See also his TED talks

And pervasive online filters of information further entrench

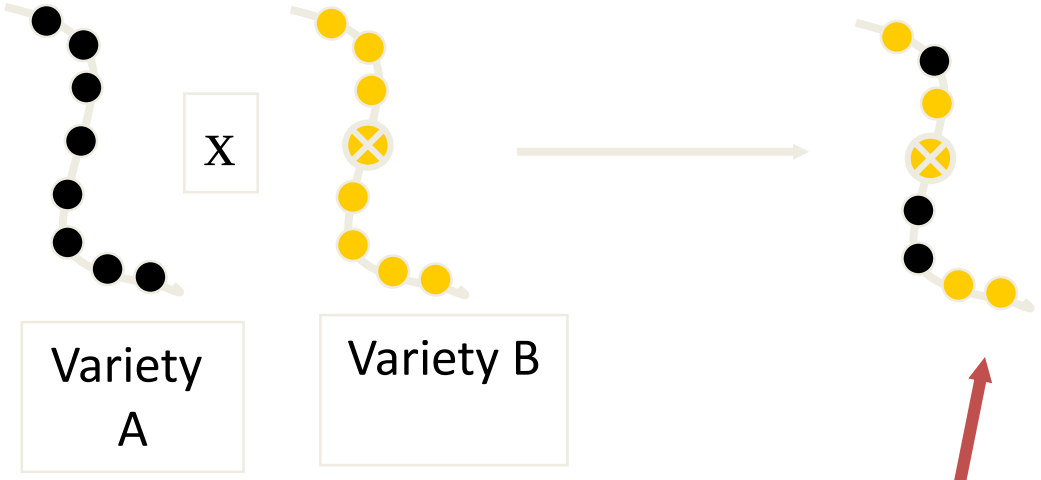
https://www.ted.com/talks/eli_pariser_beware_online_filter_bubbles



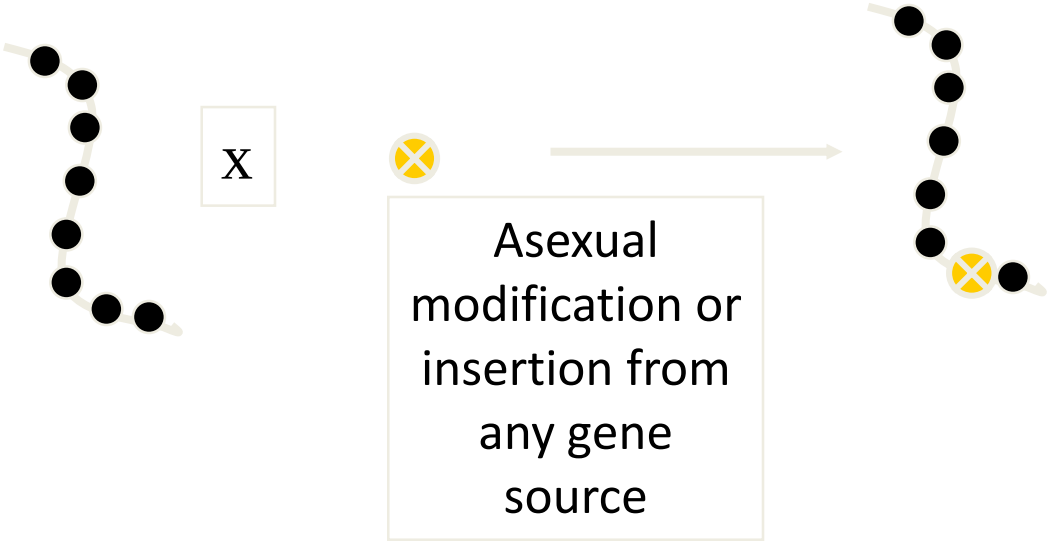
"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Genetic engineering defined

Traditional plant breeding



Genetic engineering



The GMO acronyms

- **GE (genetic engineering) = GM (genetic modification) = transgenic = asexual modification and/or insertion of DNA**

  GMO = genetically modified organism

  GEO = genetically engineered organism

  The terms "biotechnology" or "modern biotechnology" often equated with GE or GM methods in public media

Regeneration of GE plants

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

Propagation of poplars in tissue culture

Growth in the field

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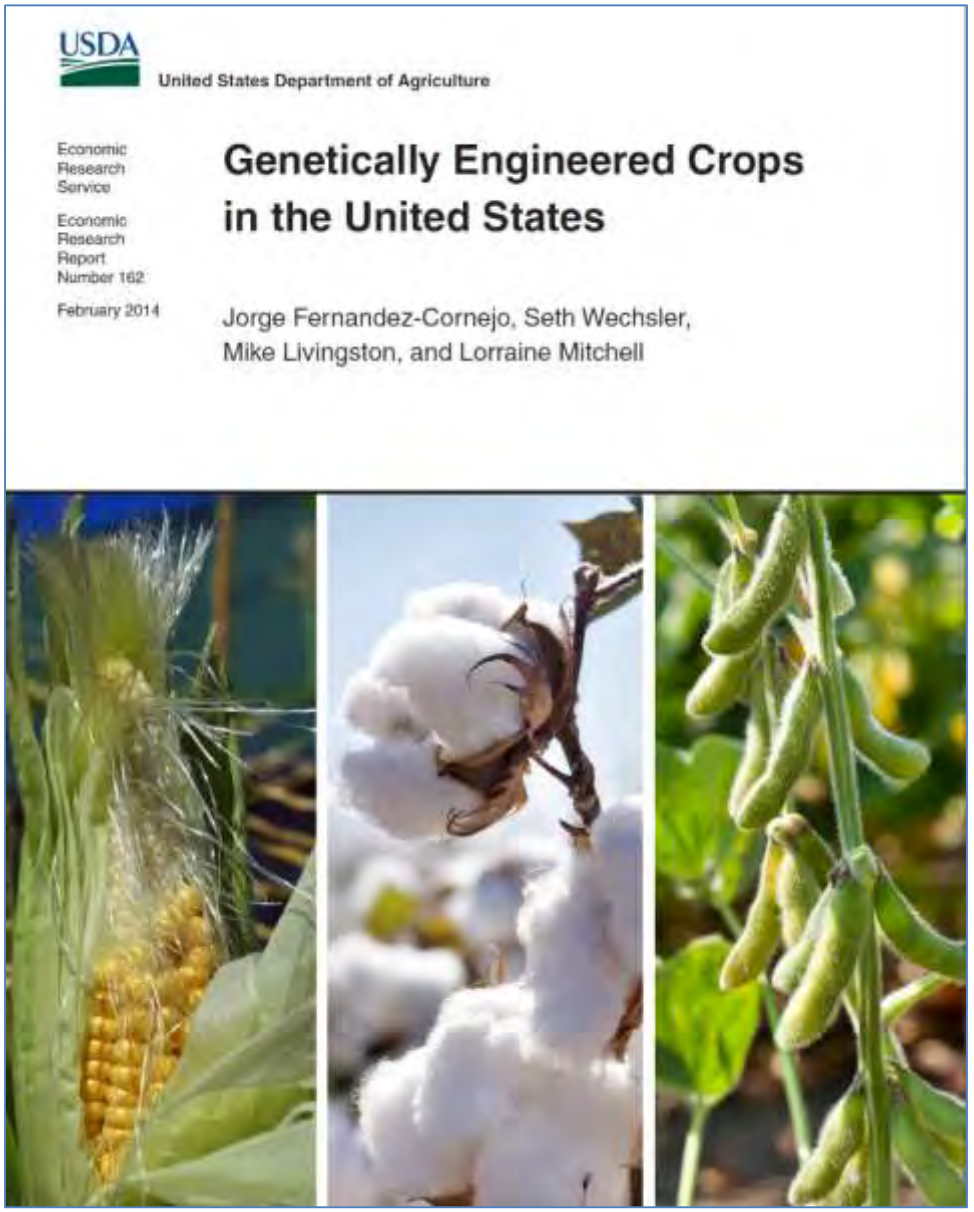
The good

Recent USDA report on GE crops in USA – published 2014



http://www.ers.usda.gov/ersDownloadHandler.ashx?file=/media/1282246/err162.pdf

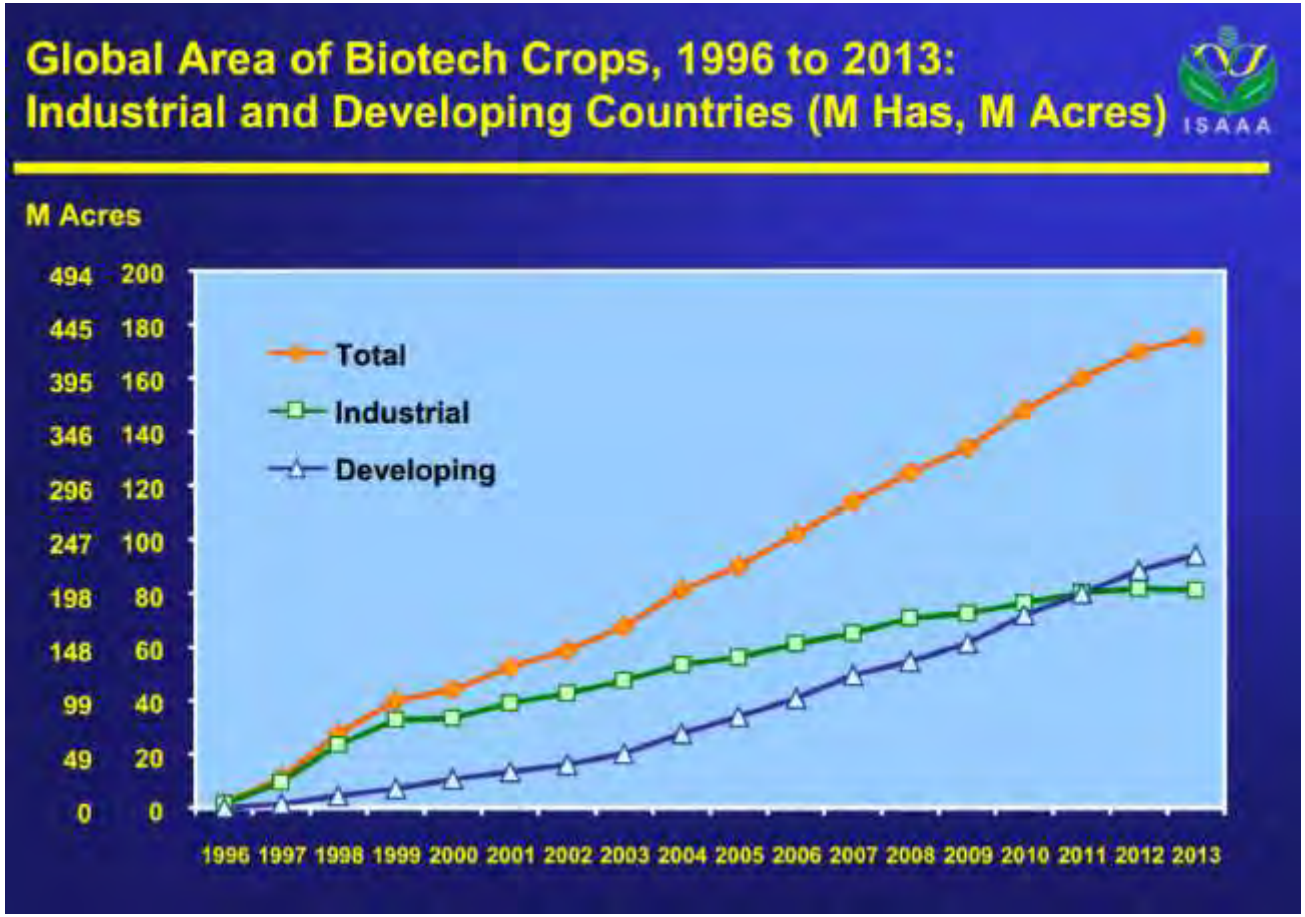
ISAAA

http://www.isaaa.org/inbrief/default.asp

GMO crops widespread

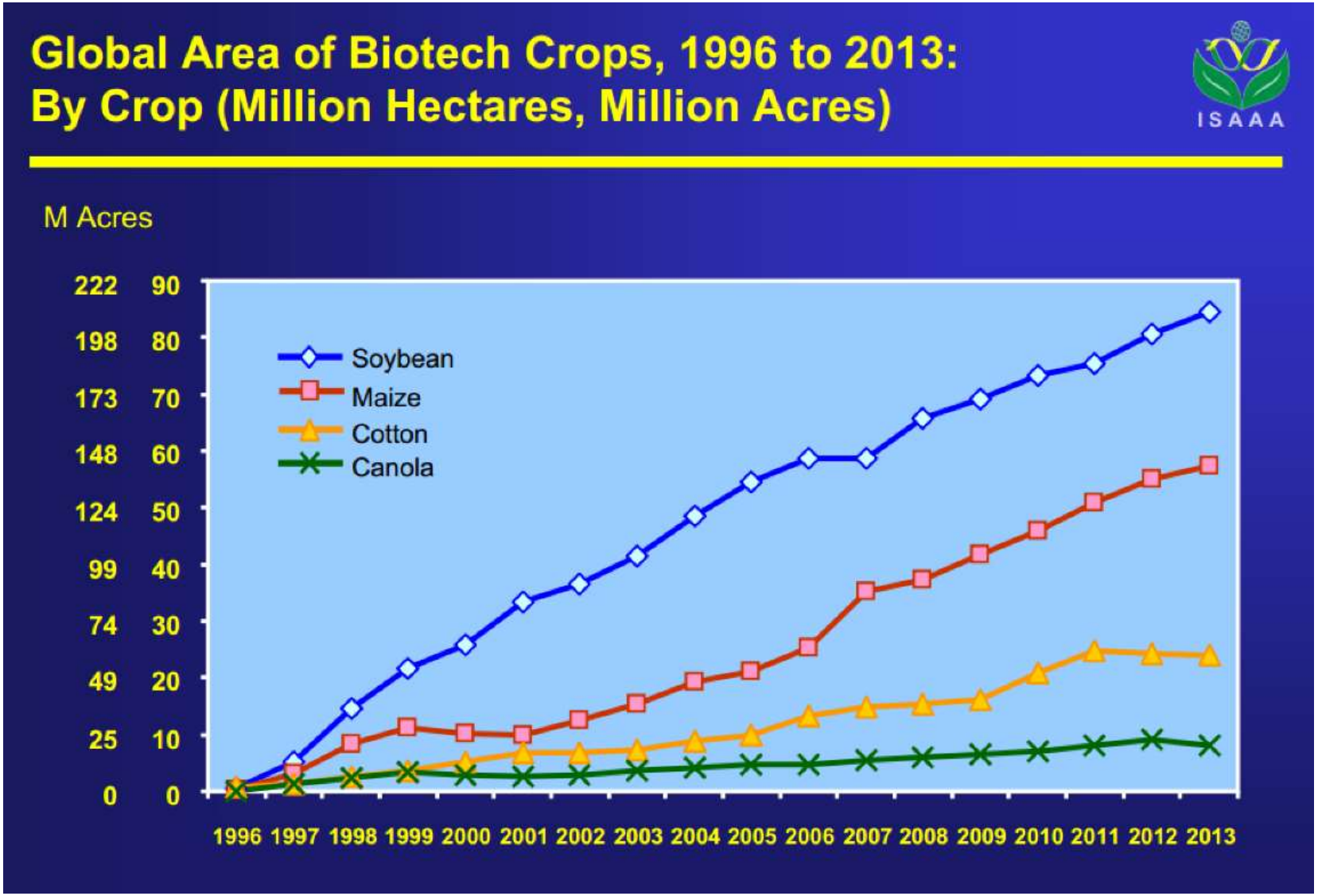
~Most rapidly adopted innovation in history of agriculture, grown on >10% arable land on planet

* ***Extensive uptake in developing world***



http://www.isaaa.org/resources/publications/briefs/46/pptslides/Brief46slides.pdf

Four crops dominate



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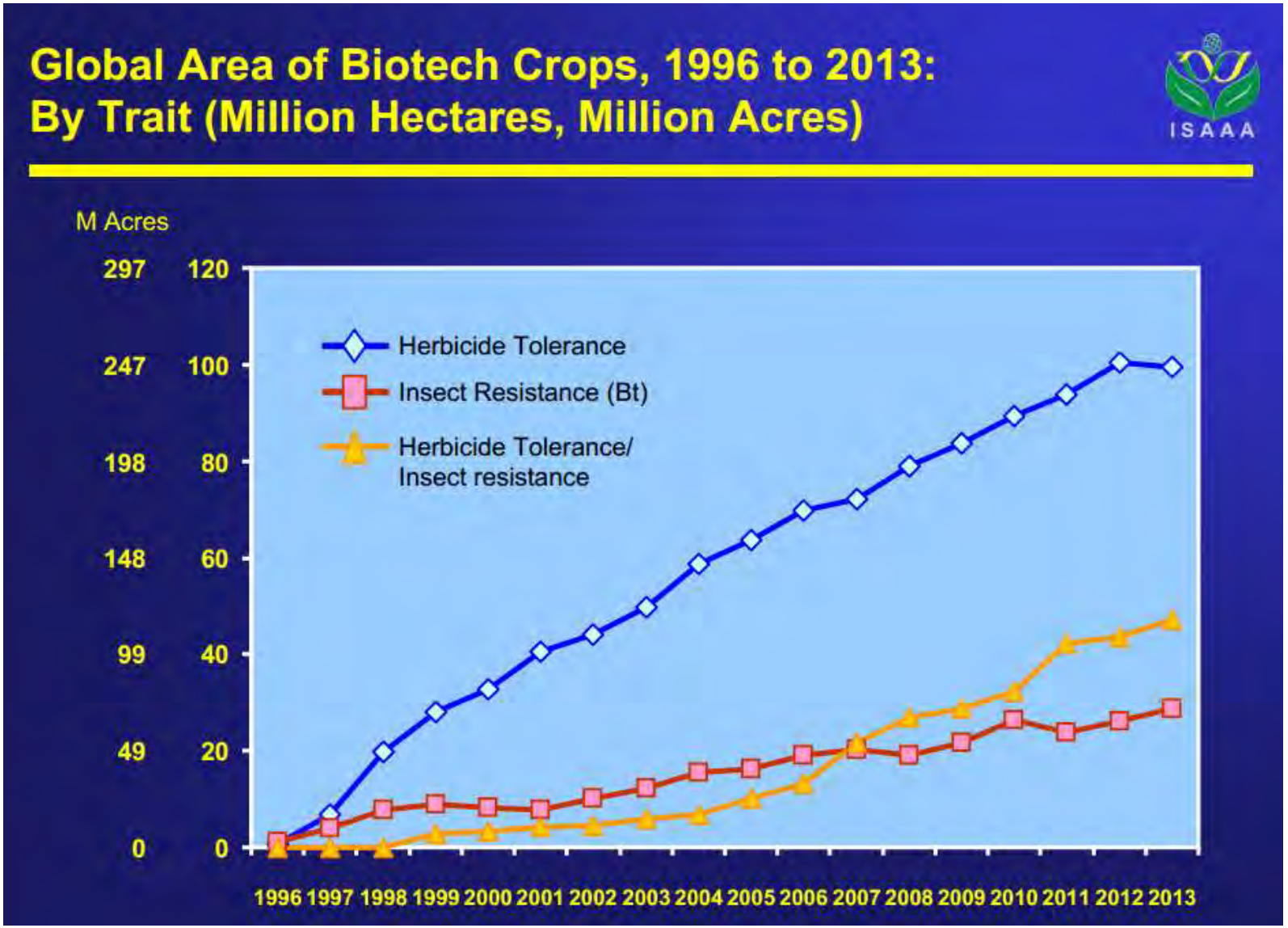
Two traits dominate



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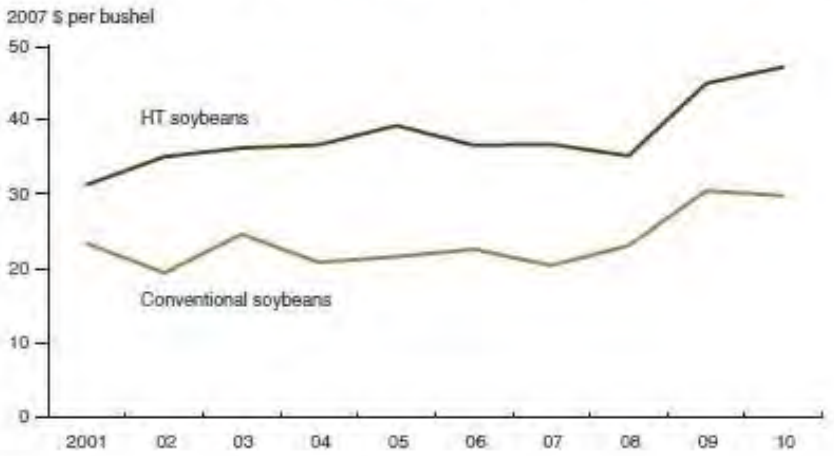
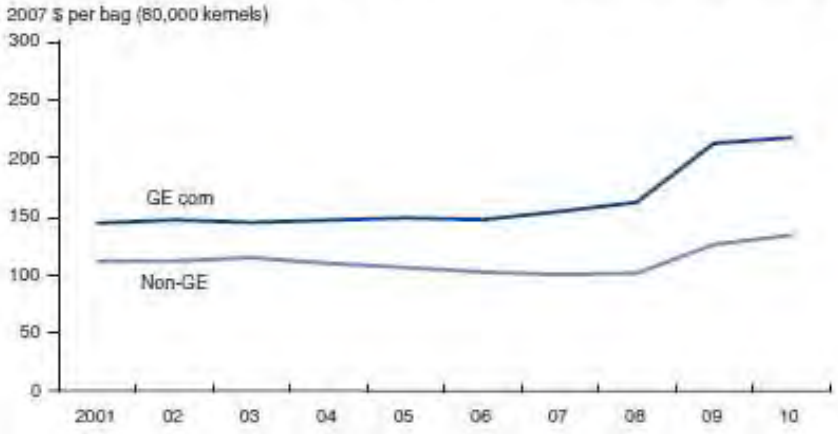
GE seed cost ~50% higher in USA

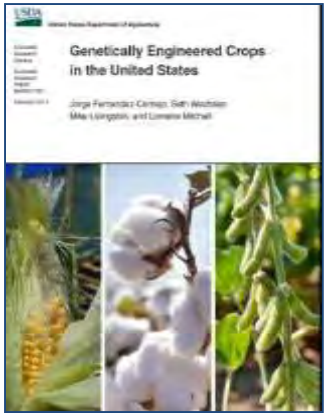
Figure 11
Prices of genetically engineered (GE) seed are higher than those of non-GE seed, soybeans



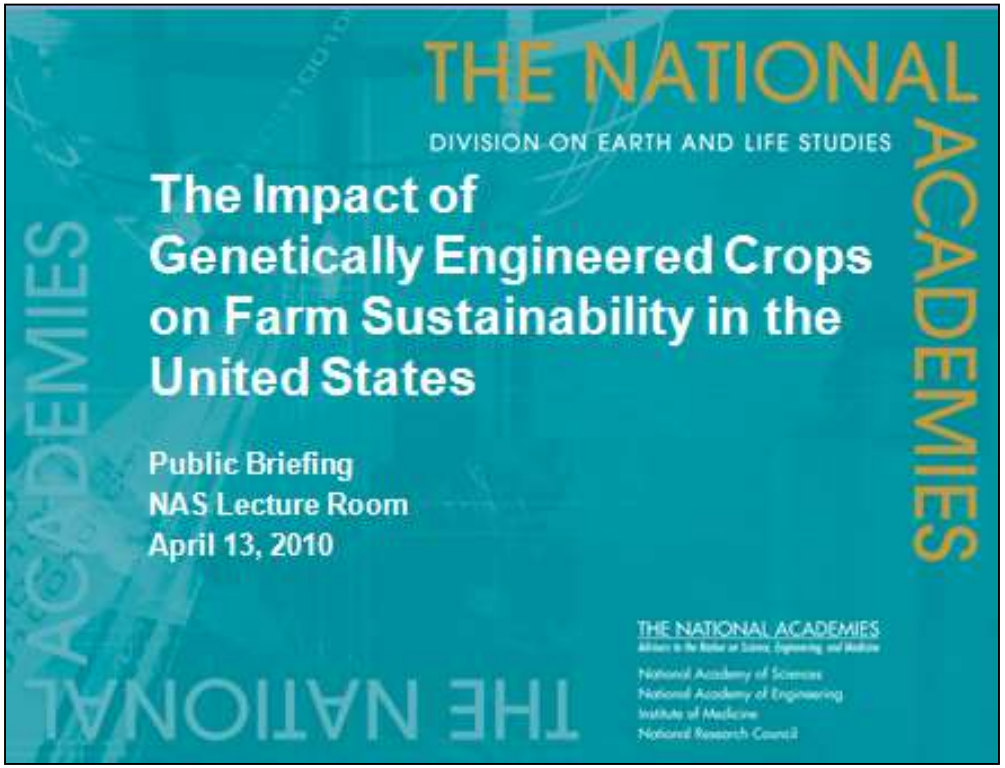
Prices of genetically engineered (GE) seed are higher than those of non-GE seed, corn



HT crops have herbicide tolerance traits.
Source: USDA Economic Research Service using data from USDA National Agricultural Statistics Service *Agricultural Prices*, various years.

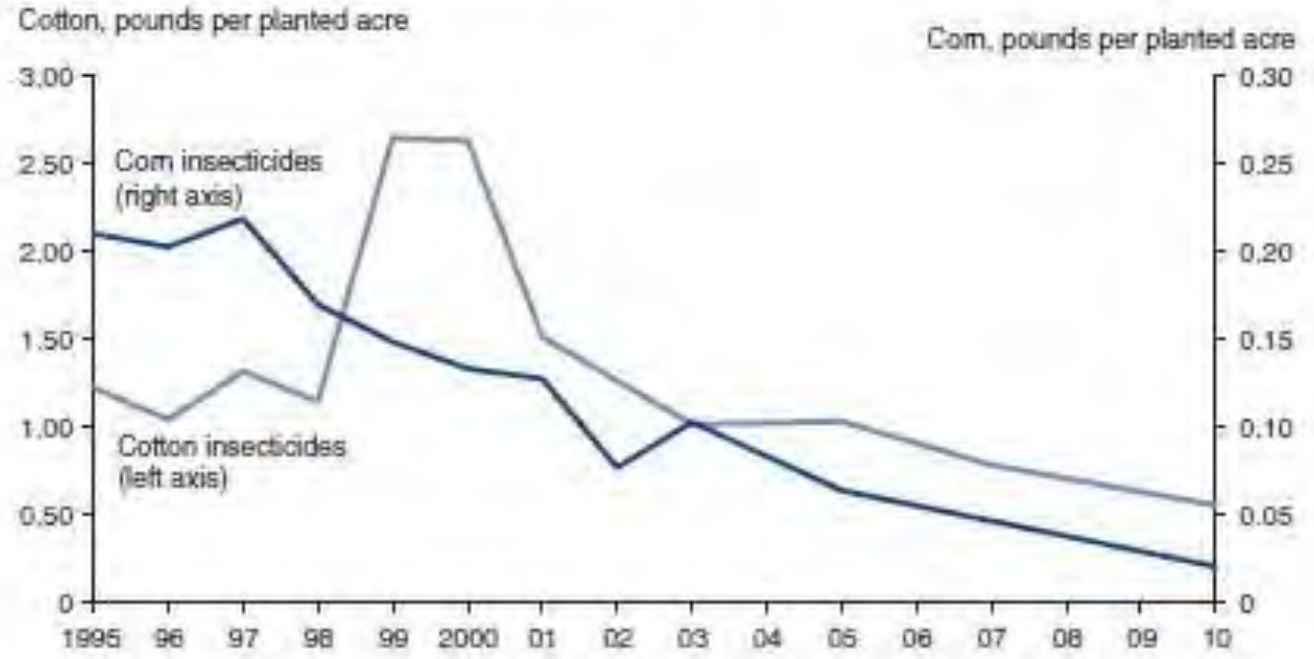


Major reports on GMO crops show very large positive impacts on economics, sustainability, in USA and worldwide

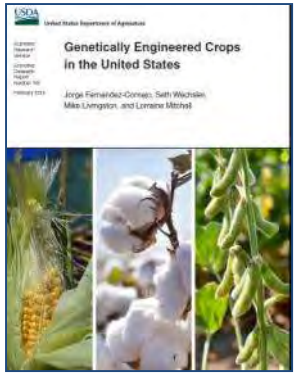


Hundreds of millions of pounds less insecticide use due to GE crops in USA: Maize and cotton

Figure 12
Insecticide use in corn and cotton production, 1995-2010



Source: USDA Economic Research Service using data from USDA National Agricultural Statistics Service Agricultural Chemical Usage reports.



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

Conservation Technology Information Center

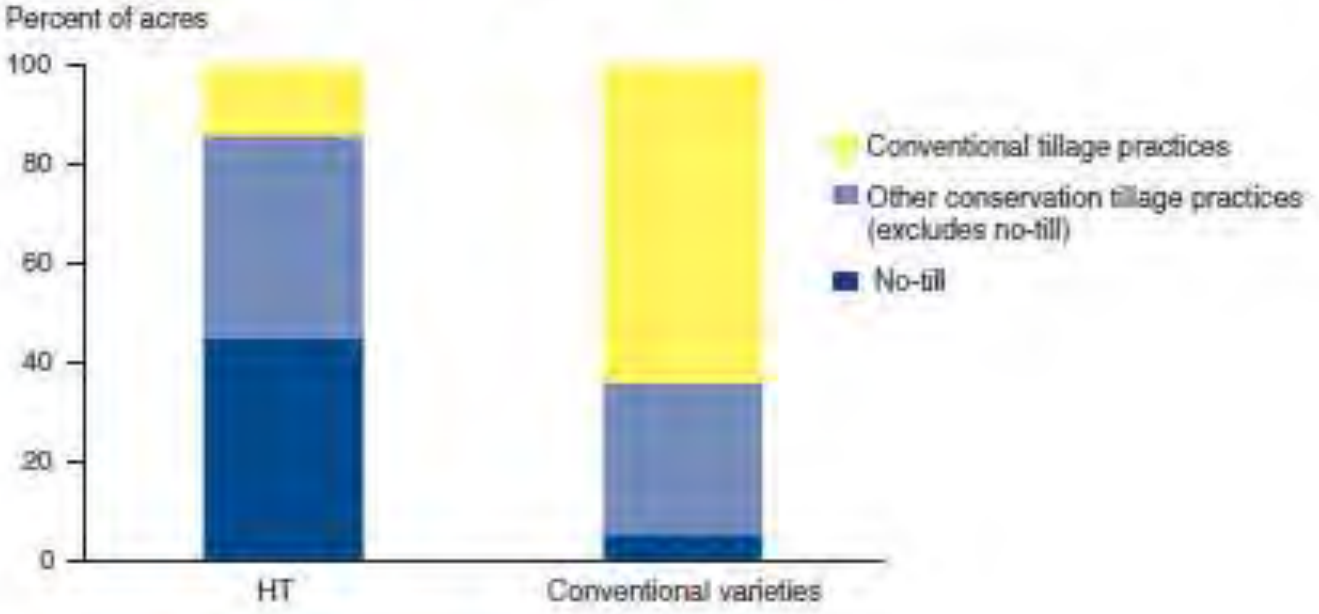
- Lowers greenhouse gas emissions
- Improves soil organic matter
- Reduces erosion and fertilizer runoff into water
- Often provides better wildlife habitat

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

Increased conservation tillage due to GE crops in USA: Soy 2006

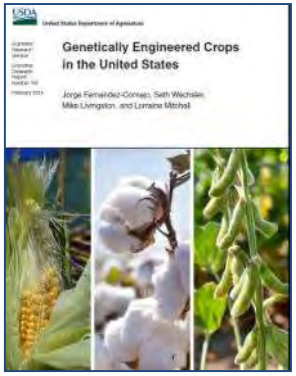
Figure 15

Adopters of herbicide-tolerant crops used conservation tillage more than did growers of conventional varieties: soybeans, 2006



Conservation tillage includes no-till, ridge-till and mulch-till.

Source: USDA Economic Research Service using data from 2006 ARMS Phase II soybean survey.



Yield benefits significant

Peer-reviewed surveys indicate positive impact of commercialized GM crops

To the Editor:
The benefits of genetically modified (GM) crops continue to be disputed, despite rapid and widespread adoption since their

farmers report yield increases that range from no change for herbicide-tolerant cotton to a 7% increase for herbicide-tolerant soybean and insect-resistant

The results show the variability of benefits from region to region and year to year. A survey of Indian cotton farmers in crop harvest years 2005–2006 through

Table 1 Number and direction of results comparing yields of GM adopters to those of non-adopters, by country

Country	Positive	Neutral	Negative	Total
Developed countries	36	18	7	61
Australia	0	2	2	4
Canada	7	0	1	8
Spain	3	6	0	9
United States	26	10	4	40
Developing countries	88	13	6	107
Argentina	5	1	0	6
China	15	0	0	15
Colombia	4	1	0	5
India				
Mexico				
Philippines				
Romania				
South Africa				
Total				

Positive and negative are

Table 2 Average impact on yield, by technology, for developed and developing countries

Technology	Difference in yield (%)	Number of results	Minimum (%)	Maximum (%)	Standard error of the mean (%)
Developed countries	6	59	12	26	1.0
Herbicide-tolerant cotton	0	6	-12	17	3.8
Herbicide-tolerant soybean	7	14	0	20	1.7
Herbicide-tolerant and insect-resistant cotton	3	2	-3	9	5.8
Insect-resistant corn	4	13	-3	13	1.6
Insect-resistant cotton	7	24	-8	26	1.9
Developing countries	29	107	-25	150	2.9
Herbicide-tolerant corn	85	1			
Herbicide-tolerant soybean	21	3	0	35	11
Insect-resistant corn	16	12	0	38	4
Insect-resistant corn (white)	22	9	0	62	6.9
Insect-resistant cotton	30	82	-25	150	3.5

Yield difference for adopters was calculated as (GM yield − conventional yield)/conventional yield, averaging yields across surveys, geographies, years and methodologies. The difference in the number of results reported in **Tables 1** and **2** is due to two results reported as 'positive' with no numerical value. A two-tailed *t* test shows a significant difference between the average yields of developed and developing countries ($t = 7.48$, $df = 134$, $P < 0.0005$).

6% mean yield improvement in developed countries

29% in developing countries

Also strong economic, environmental toxicity, and social benefits

NATURE BIOTECHNOLOGY VOLUME 28 NUMBER 4 APRIL 2010

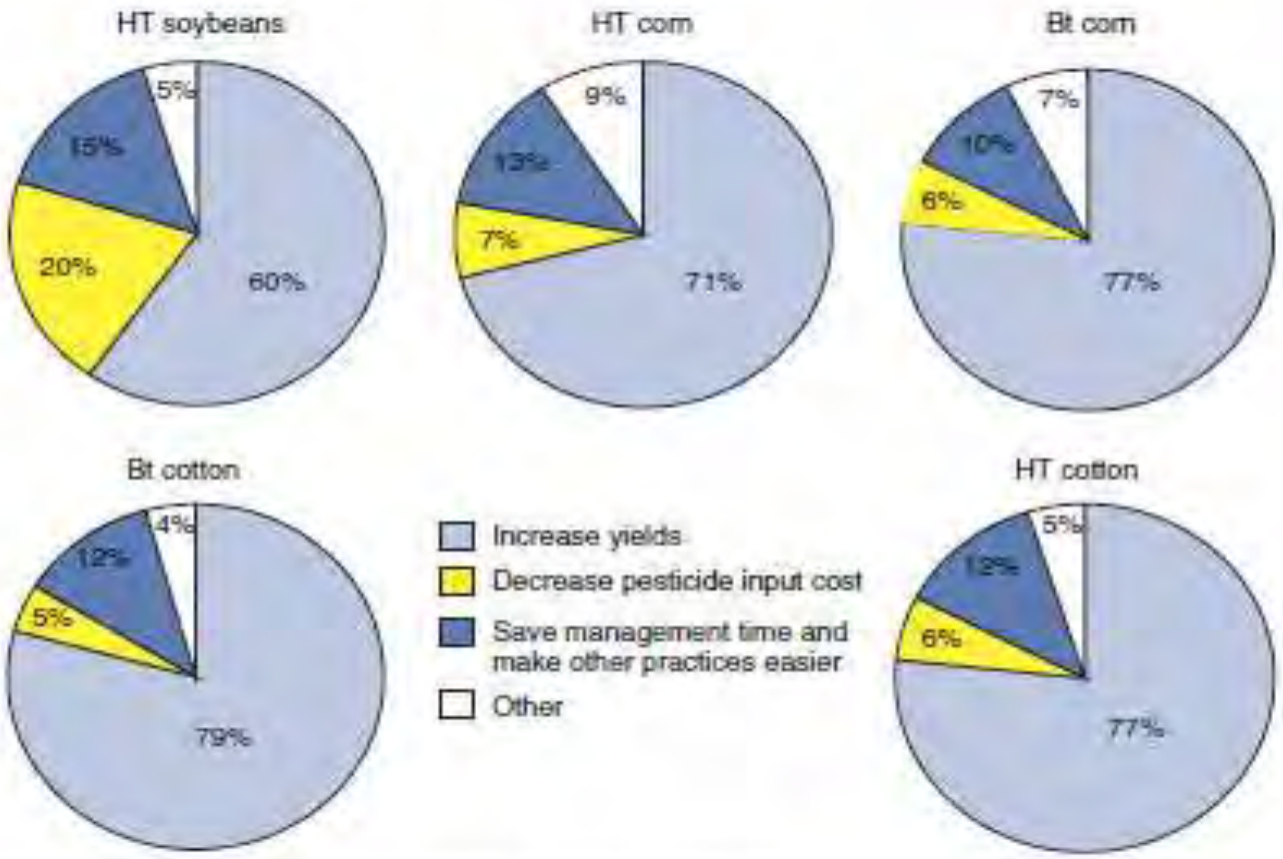
Yield benefits in USA growing with stacked traits: USDA report

"The yield advantage of Bt corn and Bt cotton over conventional seed has become larger in recent years as new Bt traits have been incorporated and stacked traits have become available. Planting Bt cotton and Bt corn continues to be more profitable, as measured by net returns, than planting conventional seeds."

Survey: USA farmers regard yield benefits as a major reason for use of GE crops

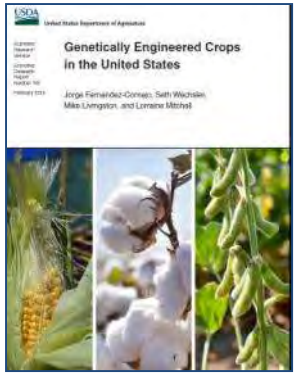
Figure 7

Farmers' reasons for adopting genetically engineered crops



Bt crops have insect resistant traits; HT crops have herbicide tolerance traits.

Sources: USDA Economic Research Service using data from Agricultural Resource Management Survey (ARMS) Phase II surveys: 2010 for corn, 2007 for cotton, and 2006 for soybeans.



Benefits provided by biotech crops, on a global scale, large: 1996-2012

- Increased crop production valued at **US$116.9 billion**
- Conserved biodiversity (indirectly) by saving 123 million hectares of land from 1996-2012
- **Helped alleviate poverty** for >16.5 million small farmers and their families totaling **>65 million people**, who are some of the poorest in the world

http://www.isaaa.org/resources/publications/briefs/46/topfacts/default.asp

Its not all mega-crops or mega-traits

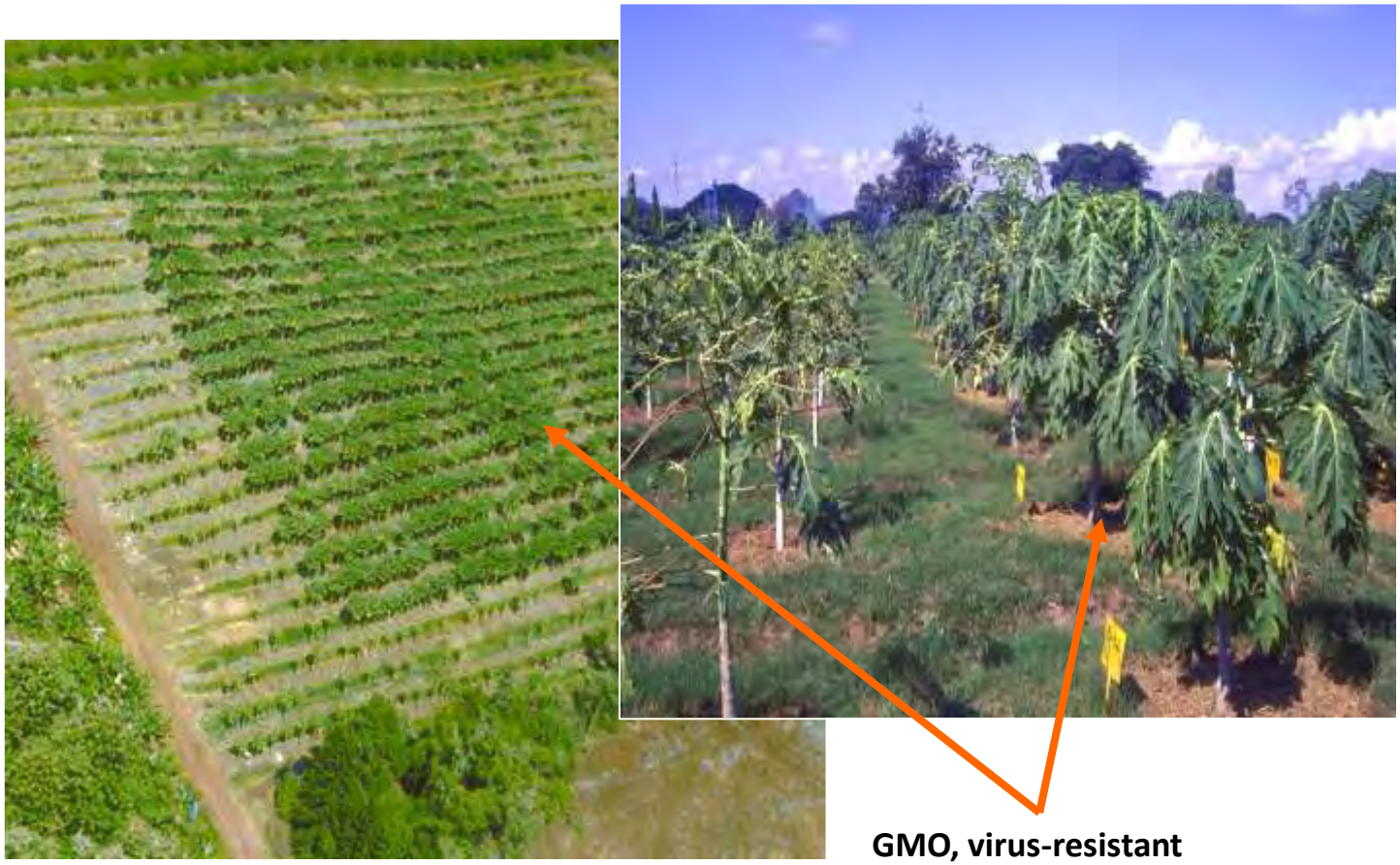
Numerous innovations have been demonstrated in lab or field research, but never make it to market

Below are a few that have or might soon….

Virus-resistant papaya saved the Hawaiian industry in the mid-1990s / ~70% of papaya today

* Nobel prize winning RNAi - “Immunization” via by implanting a viral gene in the papaya genome

* Great humanitarian potential due to wide use of papaya in developing world

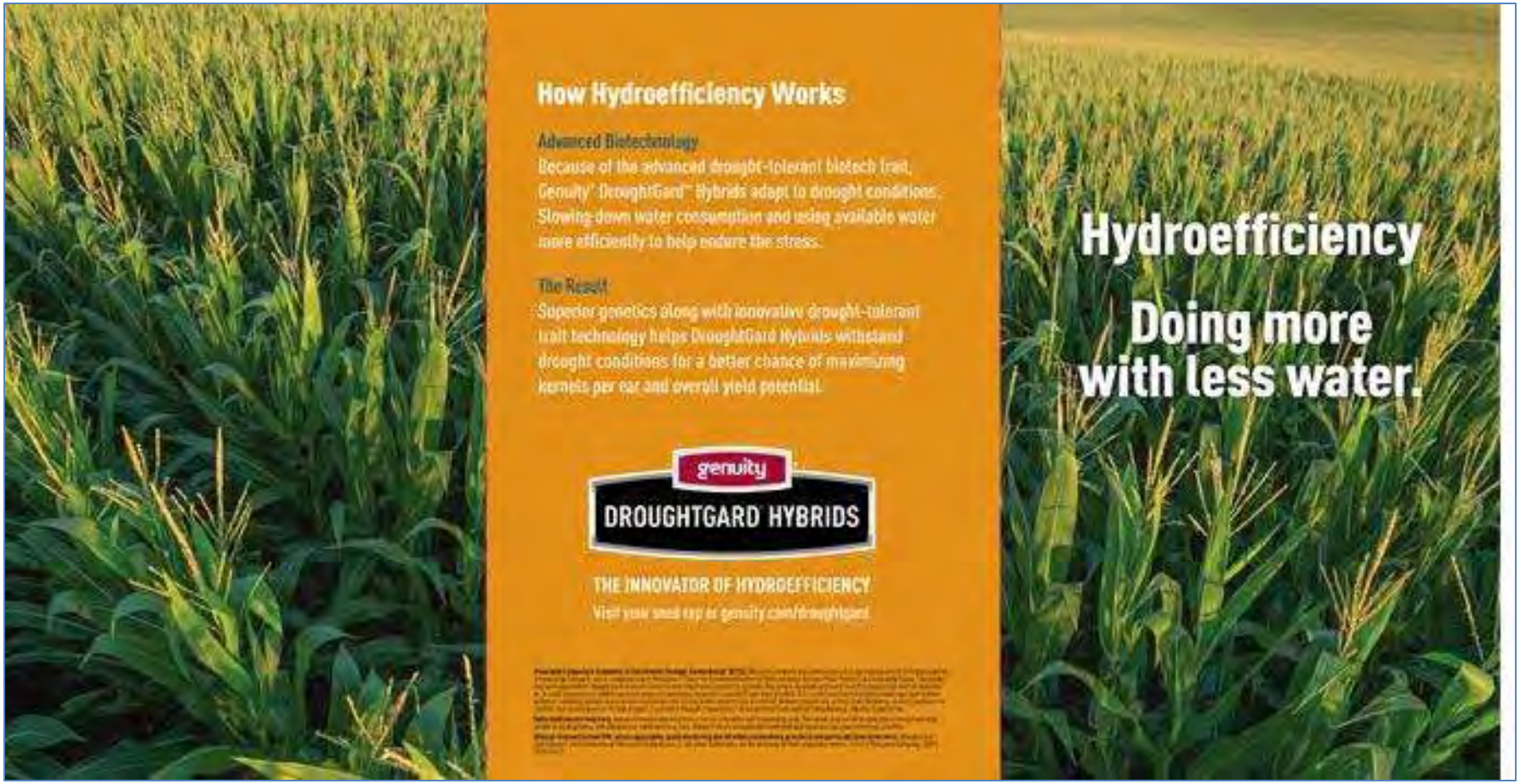


Courtesy of Denis Gonsalves, formerly of Cornell University

GMO, virus-resistant trees

Drought-tolerant maize – Planted on ~150,000 acres – Also tested in Africa

Important tool given climate change, water shortages?



Purple GM tomatoes with increased antioxidants and rot resistance

Current Biology 23, 1094–1100, June 17, 2013 ©2013 Elsevier Ltd All rights reserved http://dx.doi.org/10.1016/j.cu

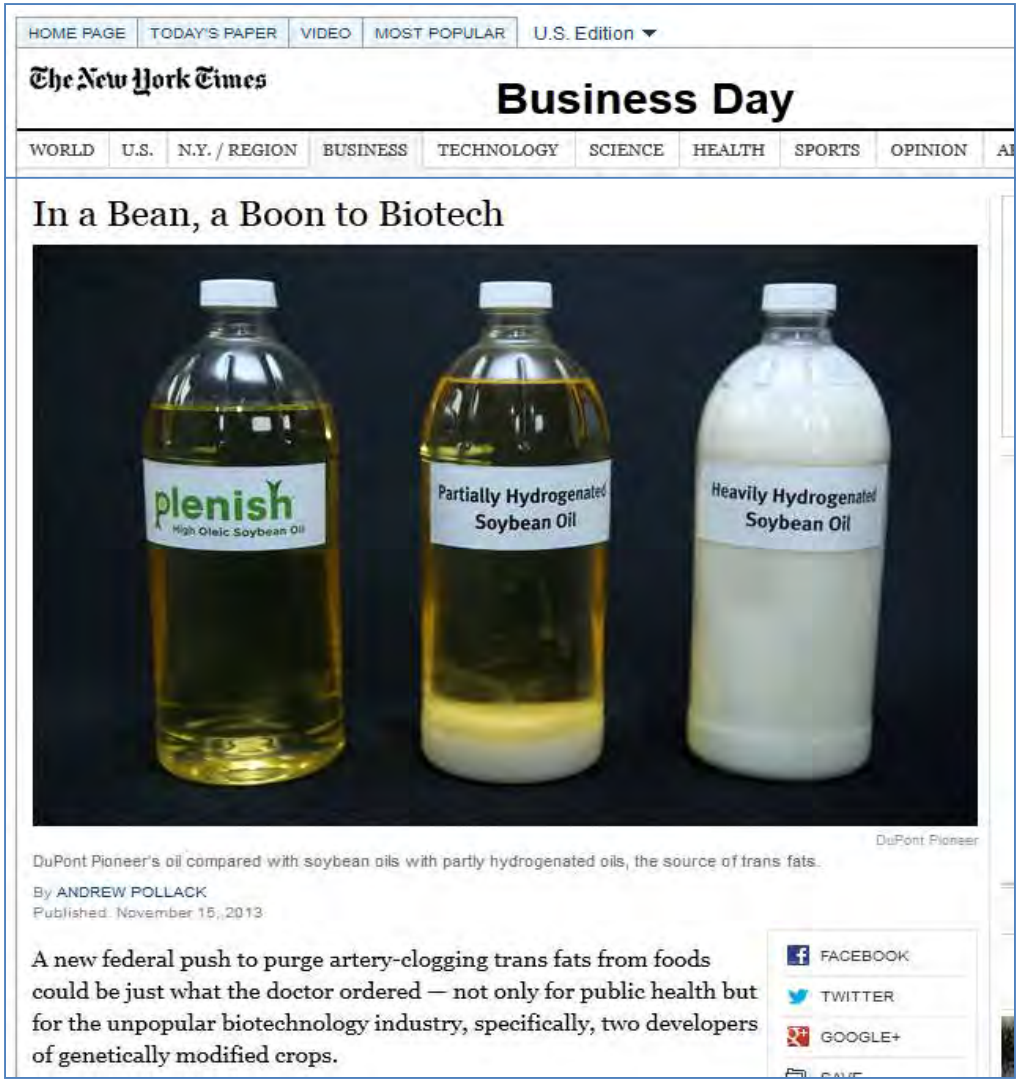
Anthocyanins Double the Shelf Life of Tomatoes by Delaying Overripening and Reducing Susceptibility to Gray Mold

Yang Zhang,[1] Eugenio Butelli,[1] Rosalba De Stefano,[2] Henk-jan Schoonbeek,[1] Andreas Magusin,[1] Chiara Pagliarani,[3] Nikolaus Wellner,[4] Lionel Hill,[1] Diego Orzaez,[5] Antonio Granell,[5] Jonathan D.G. Jones,[6] and Cathie Martin[1,*]
[1]John Innes Centre, Norwich Research Park, Norwich, NR4 7UH, UK

They are produced by plants t
dispersers [9]. Anthocyanin p
induced under stress condition
gens [11]. Besides physiologica
cyanins are associated with pro
[12], cardiovascular diseases [
disorders [13].

Improved soy oil

Suppression of native gene



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The New York Times

Business Day

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

In a Bean, a Boon to Biotech

DuPont Pioneer

DuPont Pioneer's oil compared with soybean oils with partly hydrogenated oils, the source of trans fats.

By ANDREW POLLACK
Published: November 15, 2013

A new federal push to purge artery-clogging trans fats from foods could be just what the doctor ordered — not only for public health but for the unpopular biotechnology industry, specifically, two developers of genetically modified crops.

FACEBOOK
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GOOGLE+

"The developers, Monsanto and DuPont Pioneer, have manipulated the genes of the soybean to radically alter the composition of its oil to make it longer-lasting, potentially healthier and free of trans fats."

"It almost mirrors olive oil in terms of the composition of fatty acids."

Omega-3 enhanced GM soy oil to promote health, replace fish oils

Science & the Public

SCIENCE & THE PUBLIC

TECHNOLOGY, HUMANS & SOCIETY, NUTRITION, GENES & CELLS, EARTH & ENVIRONMENT, CHEMISTRY, PLANTS, BODY & BRAIN, OTHER, AGRICULTURE

Fishy fat from soy is headed for U.S. dinner tables

For most Americans, it could help redress a critical shortfall in a beneficial nutrient

BY JANET RALOFF 11:27PM, APRIL 9, 2011

WASHINGTON, D.C. Most people have heard about omega-3 fatty

https://www.sciencenews.org/blog/science-public/fishy-fat-soy-headed-us-dinner-tables

Potato – reduced browning and acrylamide by gene suppression (↓waste, ↑safety)

Trait #1 - Silenced PPO (Enzyme)

- Non-browning when cut
- Reduced black spot bruise

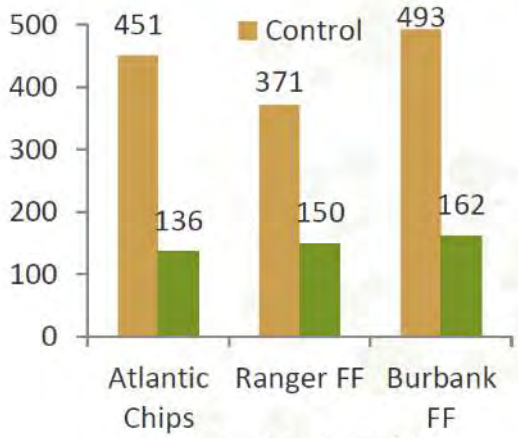
Trait #2 - Reduced Asparagine (Amino Acid)

- Yields a 50-80% reduction in acrylamide when baked or fried
- Meets Prop 65 in California

Four Improved Varieties

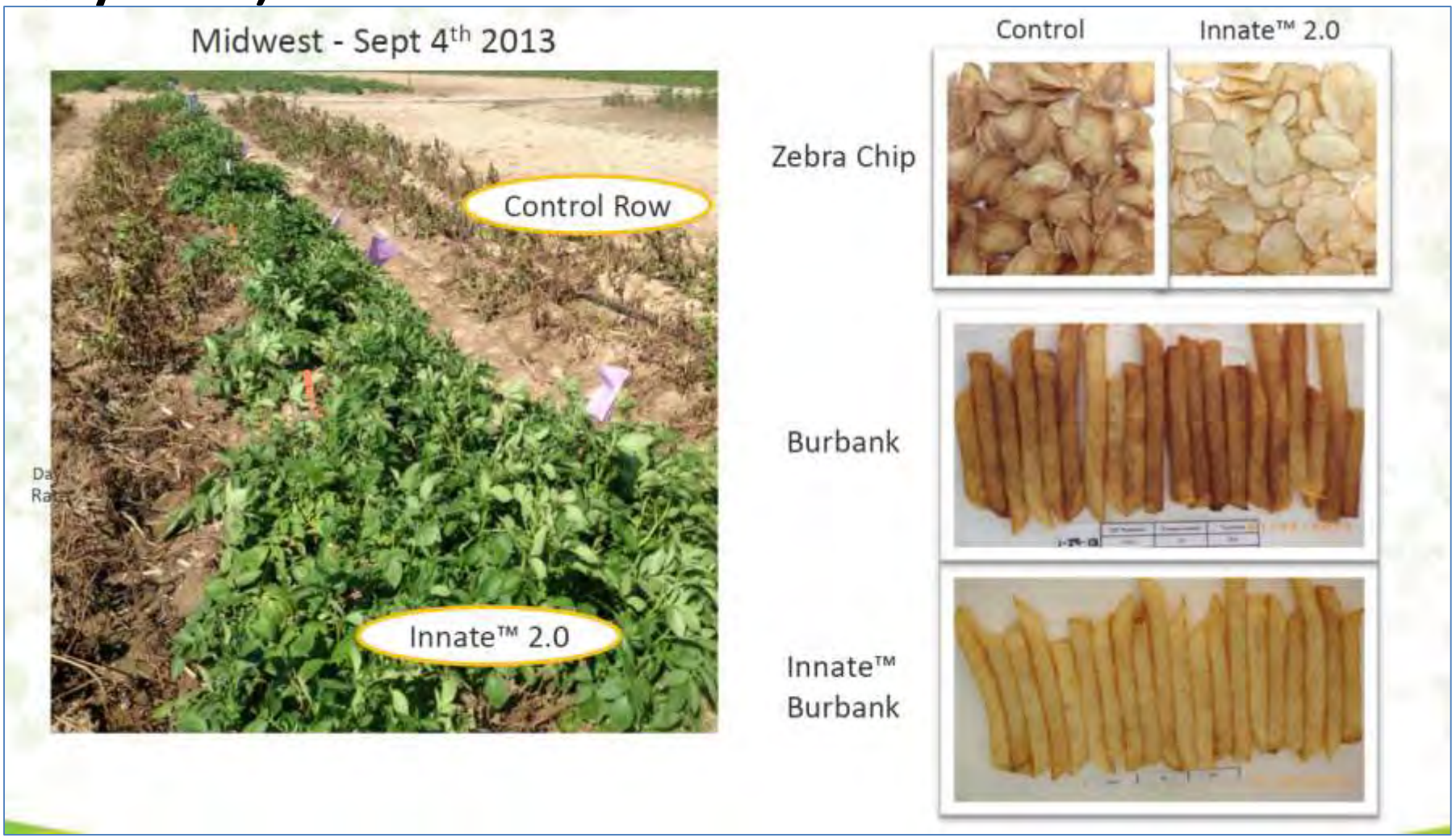
- Russet Burbank, Ranger Russet, Atlantic, Snowden
- No effect on taste, texture, or performance
- USDA approval expected in 2014

Non-Browning



Lower Acrylamide

2nd gen – blight resistant, less sprouting & over-ripening (↓pesticide, ↓waste, ↑yield)



American Chestnut restoration – genetic engineering a key tool?

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Energy & Sustainability » Scientific American Volume 310, Issue 3

The American Chestnut's Genetic Rebirth

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

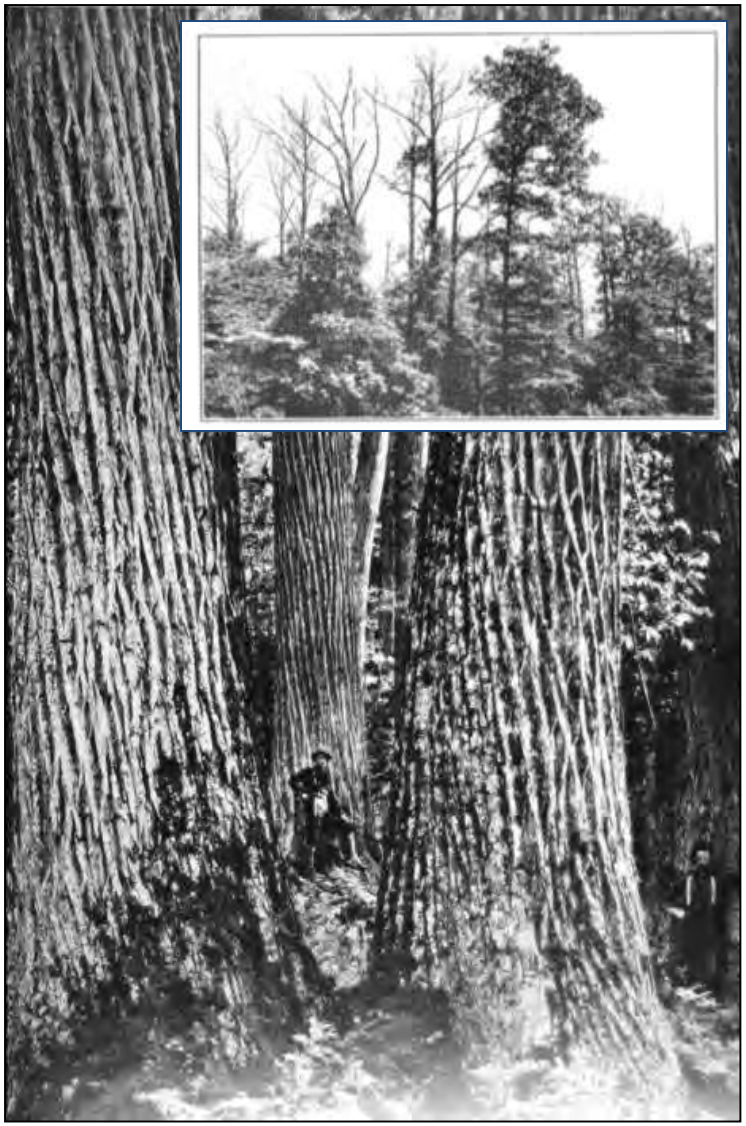
By William Powell

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

March 2014 issue - Scientific American



Biofortified plants are improving nutrition for many, and can do much more

HarvestPlus
Breeding Crops for Better Nutrition

The non-profit organization HarvestPlus focuses on the development of biofortified crops for the developing world, including a provitamin A enriched sweet potato that is **currently** being grown by half a million families. Other biofortification projects are underway to increase levels of protein, iron, zinc, antioxidants, and other beneficial components in food.

Sources: HarvestPlus; CIMMYT

Why use breeding and biotechnology for β-carotene (pro-vitamin A) enrichment?

Deficiency is widespread, impacts severe, and decades of supplements are unable to overcome

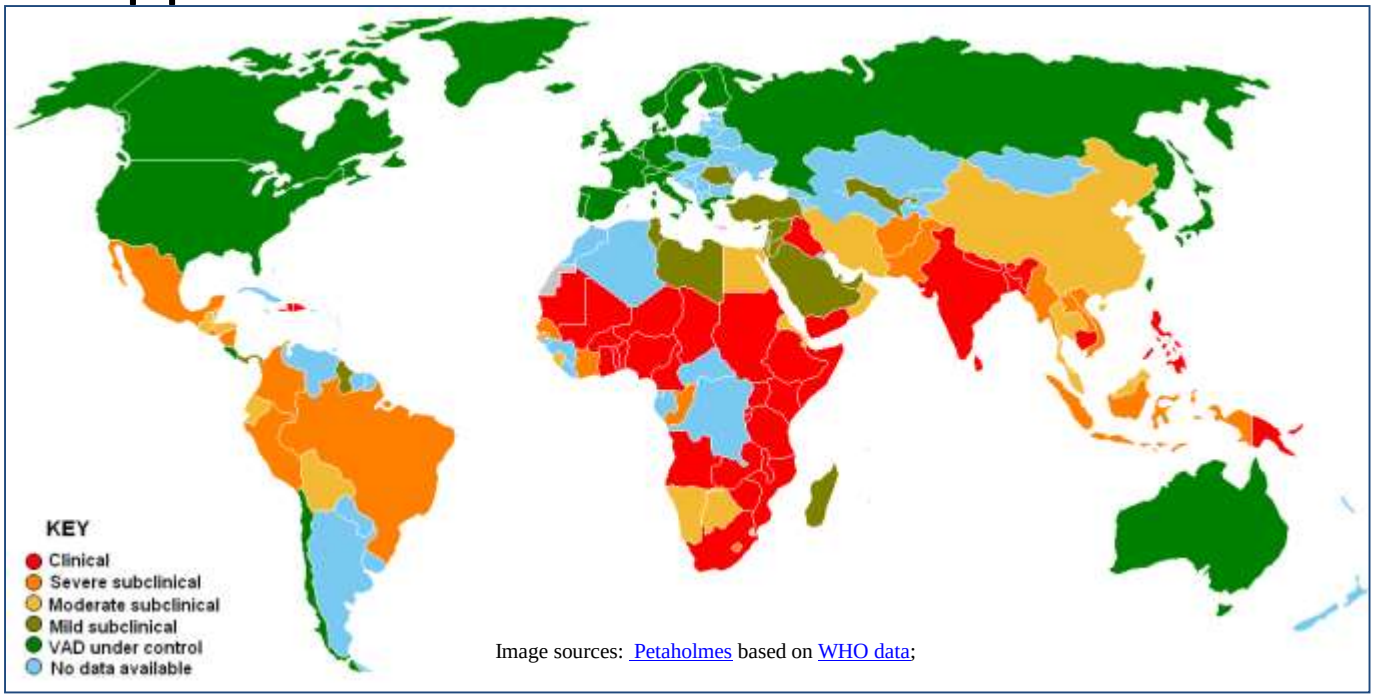
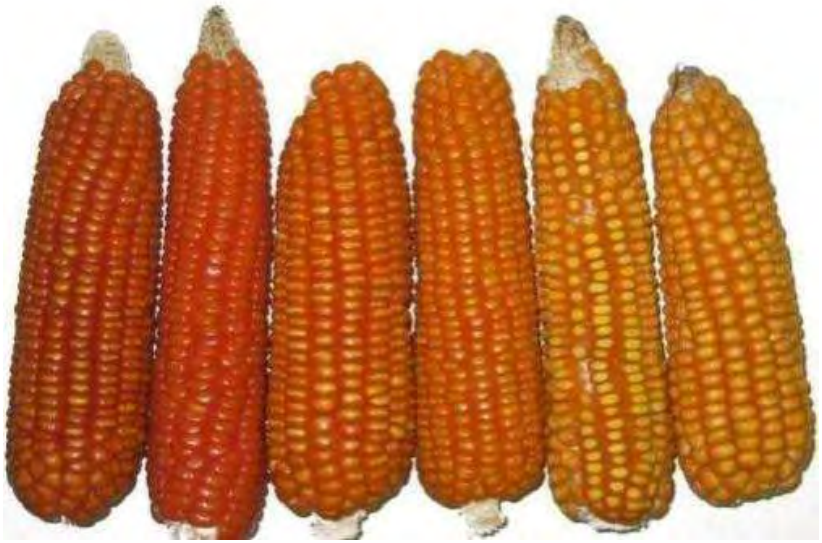


Image sources: Petaholmes based on WHO data;

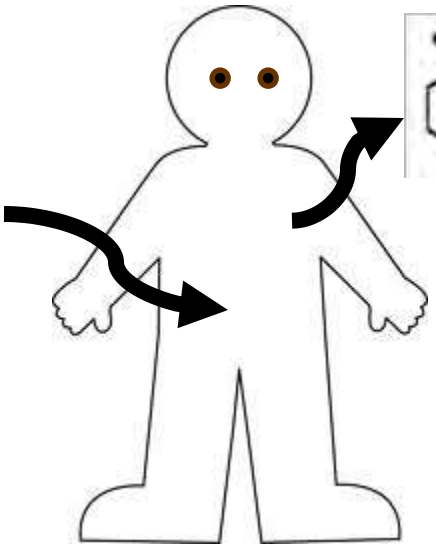
Young women suffering blindness due to Vit A deficiency

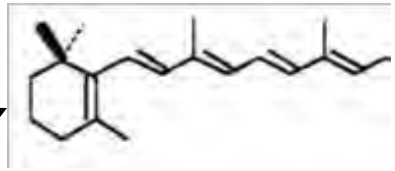
Vitamin A deficiency is estimated to affect approximately one third of children under the age of five around the world. It is estimated to claim the lives of 670,000 children under five annually. Approximately 250,000-500,000 children in developing countries become blind each year owing to vitamin A deficiency…. night blindness due to vitamin A deficiency is also high among pregnant women in many developing countries.

Breeding and GMO methods can enhance plant nutritional quality



β-carotene



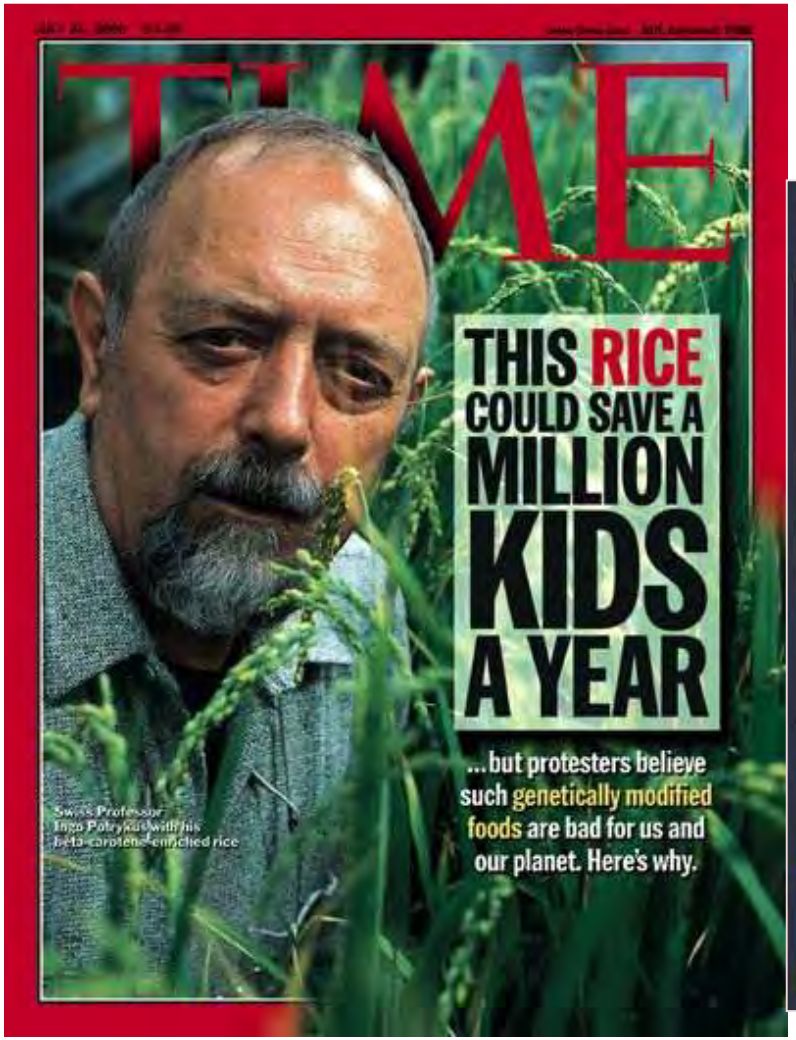


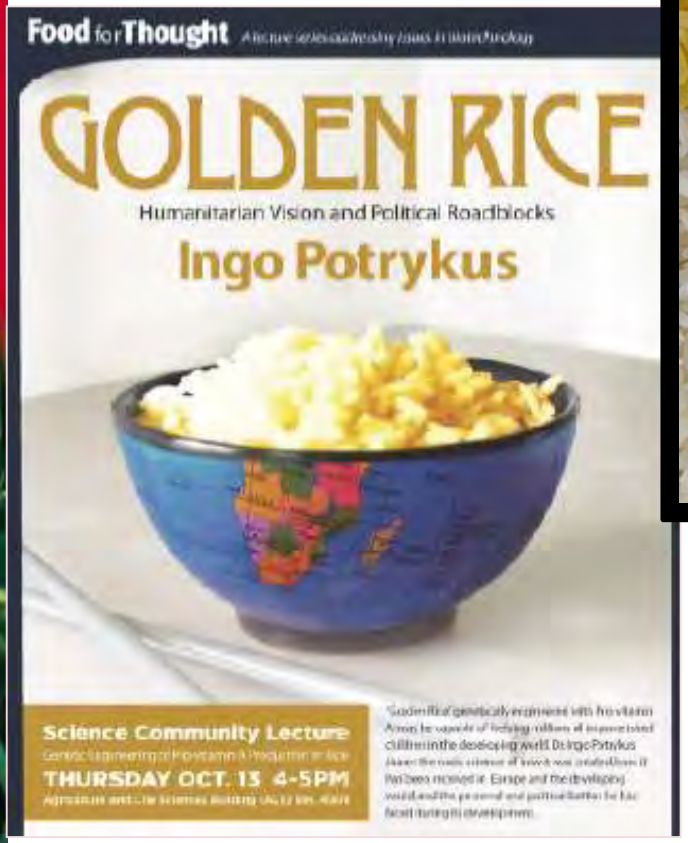
Vitamin A

The β-carotene enriched foods shown here have been produced using GM and non-GM approaches

Photo credit: Golden rice humanitarian board

Golden Rice is the most prominent GMO biofortification product under development





β-carotene makes the rice look golden

Vitamin A enrichment for the poor in Africa?

DuPont reports breakthrough in introducing beta carotene in Sorghum

In Africa, up to half a million children become blind from Vitamin A Deficiency (VAD) with increased risk of cognitive impairment, disease and death from severe infections. Furthermore, nearly 600,000 women die from c..

20 Feb 2014

IOWA, USA: Dupont has achieved a breakthrough in introducing pro-vitamin (beta carotene) into sorghum, a stap food in Africa which is naturally deficient in key nutrients.

This is epxected to help improve nutrition for nearly 300 mn people in Africa dependent on Sorghum. DuPont said that the ability to achieve 100 % of the recommended daily allowance of vitamin A in children from Sorghum has never been achieved before.

In Africa, up to half a million children become blind from Vitamin A Deficiency (VAD) with increased risk of cognitive impairment, disease and death from severe infections. Furthermore, nearly 600,000 women die from childbirth-related causes, many from complications that could be reduced through more vitamin A in their diet.

http://www.commodityonline.com/news/dupont-reports-breakthrough-in-introducing-beta-carotene-in-sorghum-58036-3-58037.html

The bad

Poor weed management has led to rapid development of herbicide tolerant weeds

nature biotechnology

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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)

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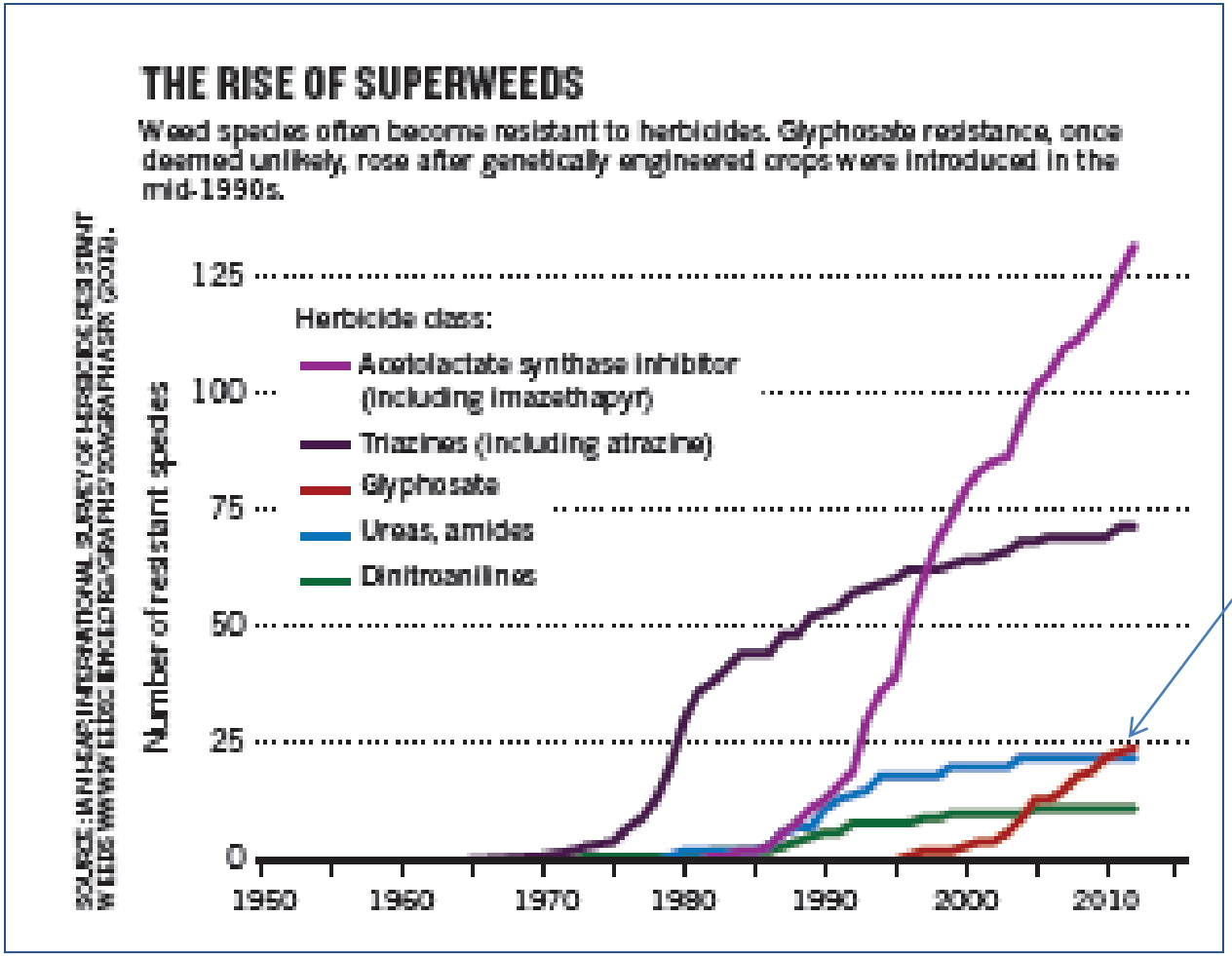
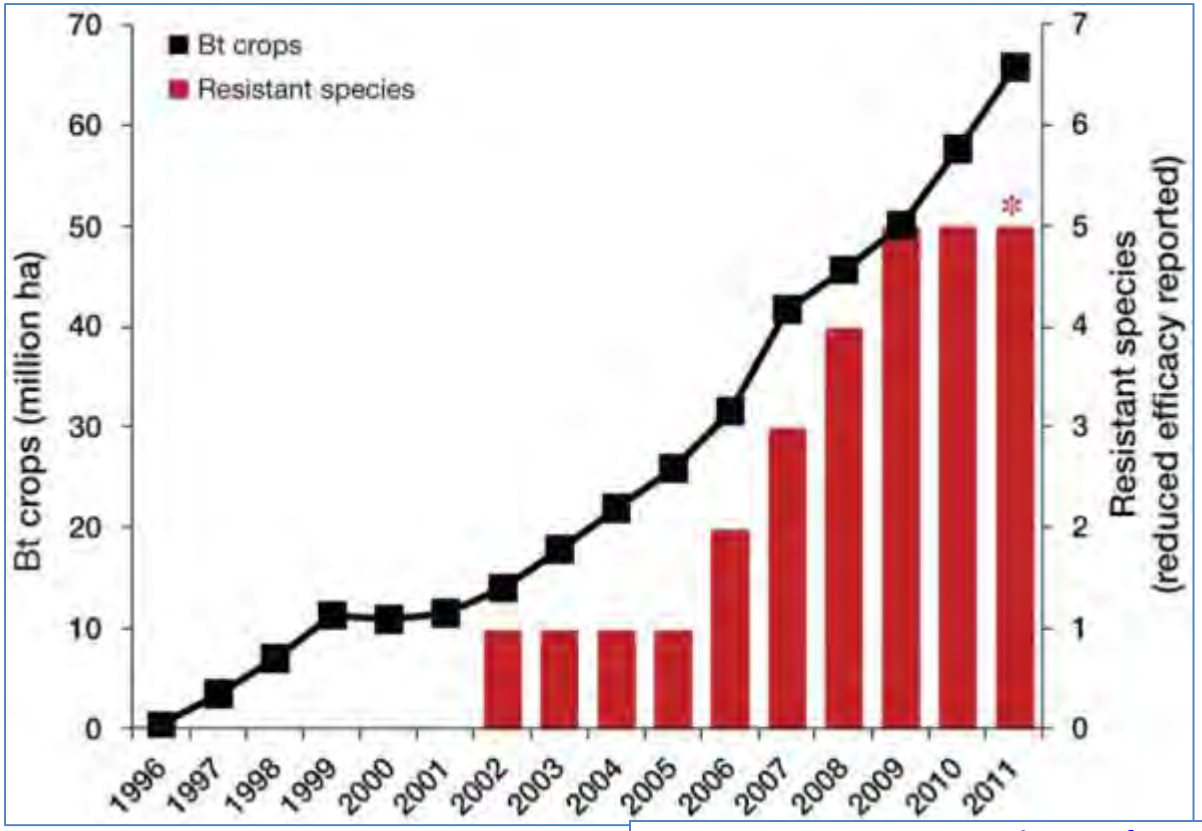
"The number of weed species evolving resistance to glyphosate

Herbicide-resistant weeds are an old problem in agriculture



Accelerated by GE Roundup-tolerant crops

Insect resistance has developed too, but has been much better managed



Insect resistance to Bt crops: lessons from the first billion acres
Nature Biotechnology, 31, 510–521 (2013)

Analogous to antibiotics, continued benefits require integrated management, and inputs of new genes/traits

Insecticide resistant crops not new – first noted 100 years ago

EntomologyToday

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The First Journal Article on Insecticide Resistance was Published 100 Years Ago this Month

April 8, 2014 by Entomology Today | Leave a Comment

One hundred years ago this month, an entomologist at the Washington Agricultural Experiment Station named A. L. Melander published an article in the *Journal of Economic Entomology* called "Can Insects Become Resistant to Sprays?" It is widely regarded as the first ever published article on arthropod resistance to insecticides.

Are declines in monarch butterflies--associated with reduced milkweed populations--due to improved weed control from herbicide-tolerant crops?

environment360
Opinion, Analysis, Reporting & Debate

01 APR 2013: INTERVIEW

Tracking the Causes of Sharp Decline of the Monarch Butterfly

A new census found this winter's population of North American monarch butterflies in Mexico was at the lowest level ever measured. Insect ecologist Orley Taylor talks to Yale Environment 360 about how the planting of genetically modified crops and the resulting use of herbicides has contributed to the monarchs' decline.

BY RICHARD CONNIFF

University of Kansas insect ecologist Orley R. "Chip" Taylor has been observing the fragile populations of monarch butterflies for decades, but he says he has never been more concerned about their future.

Monarchs are beloved for their spectacular migration across Canada and the United States to overwintering sites in central Mexico — and back again. But a new census taken at the monarchs' wintering grounds found their population had declined 59 percent over the previous year and was at the lowest level ever measured.

In an interview with *Yale Environment 360* contributor Richard Conniff, Taylor — founder and director of Monarch Watch, a conservation and outreach program — talked about the factors that have led to the sharp drop in the monarch population. Among them, Taylor said, is the increased planting of genetically modified corn in the U.S. Midwest, which has led to greater use of herbicides, which in turn kills the milkweed that is a prime food source for the butterflies.

Orley Taylor

ABOUT THE AUTHOR

Richard Conniff, who conducted this interview for *Yale Environment 360*, is a National Magazine Award-winning writer whose articles have appeared in *Time*, *Smithsonian*, *The Atlantic*, *National Geographic*, and other publications. He is the author of several books, including *The Species Seekers: Heroes, Fools, and the Mad Pursuit of Life on Earth*. In previous articles for *Yale Environment 360*, he has written about the pricing of ecosystem services and about new advances that could help produce food crops that can thrive as the

RELATED ARTICLES

Into the Heart of Ecuador's Yasuni

Few places on earth harbor as much biodiversity as Ecuador's Yasuni Biosphere Reserve, which sits atop vast deposits of oil and now faces intense development pressure. In a Yale Environment 360 video, filmmaker Ryan Killackey travels to the heart of Yasuni with scientists inventorying its stunning wildlife and plants. The researchers hope their work will bolster initiatives to preserve this threatened land.

READ MORE

Continued worry over safety of approved GMO food for human health

FEATURE

How safe does transgenic food need to be?

Laura DeFrancesco

Disputes over how to assess a foodstuff's safety continue to play into public fears about transgenic crops.

Transgenic crops are the most highly regulated foods in the world. In recent years, there have been calls in the United States to relax some of the rules for their oversight. And yet controversies over the safety of transgenic food products continue to rumble, particularly in Europe, Africa and now further afield in the Far East. Despite the fact that numerous national and international scientific panels have concluded that food derived through transgenic approaches is as safe as food produced in other ways and that food-borne pathogens pose a much greater threat to human health[1], scare stories continue to

any finished food placed on the market meets the safety levels implicit in the definition of adulterated foods. FDA is authorized to seek sanctions against foods that do not adhere to these standards through seizure, injunction or criminal prosecution," writes Emily Marden of the University of British Columbia's Faculty of Law in Vancouver[3]. This holds for all new foods, whether transgenic or not.

Notwithstanding the absence of legal underpinnings, a *de facto* regulatory process (called a consultation) exists at the FDA, whereby companies submit information on new genetically modified foods destined for the market

Laura DeFrancesco is Senior Editor at Nature Biotechnology.

Regulation of Biotechnology was laid out (51 Fed. Reg. 23302, June 26, 1986)[5]. Depending on the exact nature of the change made to

Nutrition that is responsible for oversight of the safety of food derived from transgenic crops destined for human consumption.

Very weak science in a number of highly publicized GMO toxicity studies

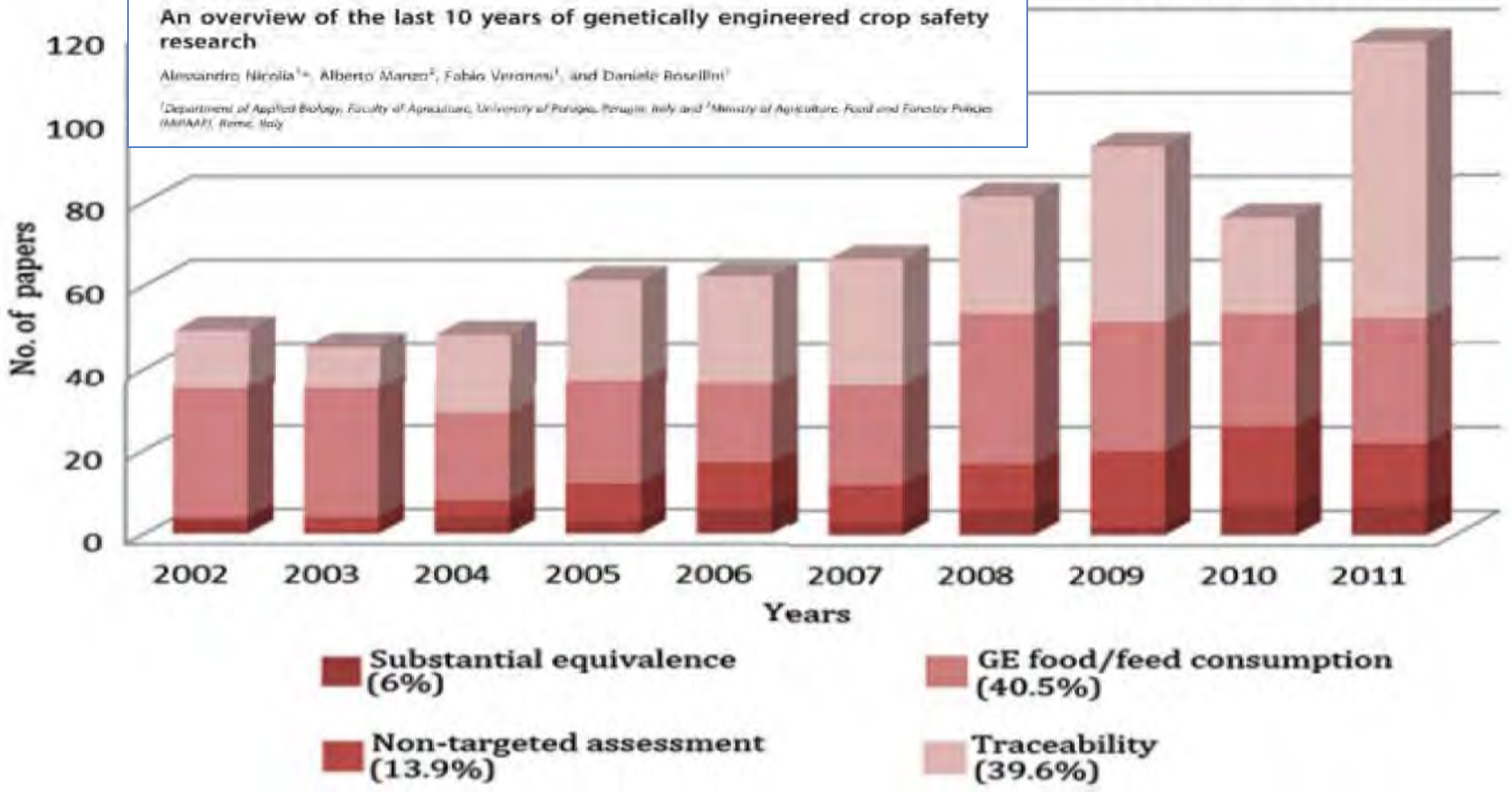
Hundreds of scientific studies of GM crop food and environmental safety

Critical Reviews in Biotechnology
informa healthcare

REVIEW ARTICLE

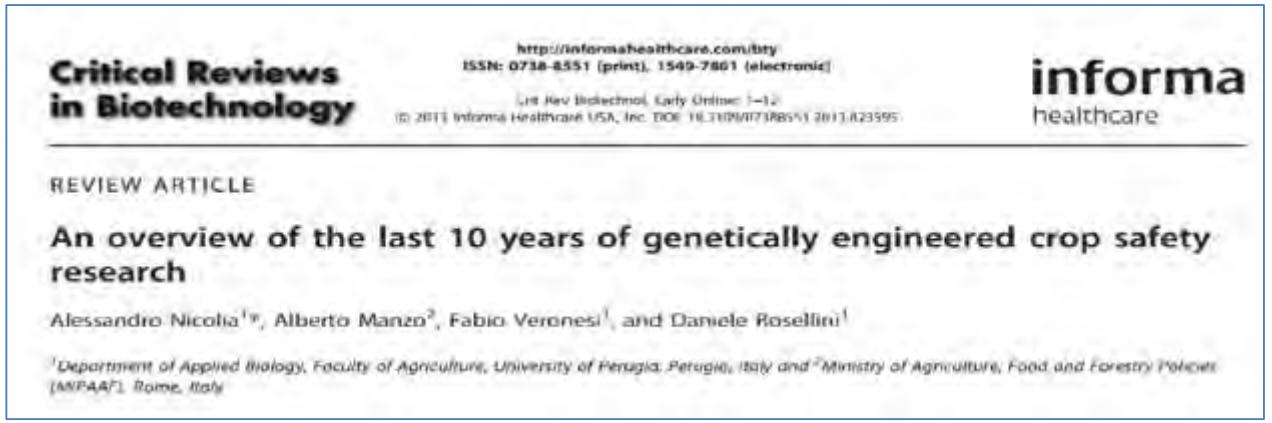
An overview of the last 10 years of genetically engineered crop safety research

Alessandro Nicolia, Alberto Manzo, Fabio Veronesi, and Daniele Rosellini



Overwhelming conclusion of food/feed safety

"The experimental data collected so far on authorized GE crops can be summarized as follows: (a) there is no scientific evidence of toxic or allergenic effects...."



Critical Reviews in Biotechnology
http://informahealthcare.com/bty
ISSN: 0738-8551 (print), 1549-7801 (electronic)
informa healthcare

REVIEW ARTICLE

An overview of the last 10 years of genetically engineered crop safety research

Alessandro Nicolia[1]*, Alberto Manzo[2], Fabio Veronesi[1], and Daniele Rosellini[1]

[1]Department of Applied Biology, Faculty of Agriculture, University of Perugia, Perugia, Italy and [2]Ministry of Agriculture, Food and Forestry Policies (MIPAAF), Rome, Italy

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

Hundreds of scientific studies of glyphosate (active ingredient – Roundup)

Regulatory Toxicology and Pharmacology **31,** 117–165 (2000)
doi:10.1006/rtph.1999.1371, available online at http://www.idealibrary.com on IDEAL®

Safety Evaluation and Risk Assessment of the Herbicide Roundup[1] and Its Active Ingredient, Glyphosate, for Humans

Gary M. Williams,* Robert Kroes,† and Ian C. Munro‡,[2]

*Department of Pathology, New York Medical College, Valhalla, New York 10595; †RITOX, Universiteit Utrecht, P.O. Box 80176, NL-3508 TD Utrecht Yalelaan 2, The Netherlands; and ‡Cantox Health Sciences International, 2233 Argentia Road, Suite 308, Mississauga, Ontario L5N 2X7, Canada

Received December 6, 1999

Reviews on the safety of glyphosate and Roundup herbicide that have been conducted by several regulatory agencies and scientific institutions worldwide have concluded that there is no indication of any human health concern. Nevertheless, questions regarding their safety are periodically raised. This review was undertaken to produce a current and comprehensive safety evaluation and risk assessment for hu-

tive parameters in two multigeneration reproduction studies with glyphosate. Likewise there were no adverse effects in reproductive tissues from animals treated with glyphosate, AMPA, or POEA in chronic and/or subchronic studies. Results from standard studies with these materials also failed to show any effects indicative of endocrine modulation. Therefore, it is concluded that the use of Roundup herbicide does not result in adverse effects on development, repro-

Overwhelming conclusion of human safety

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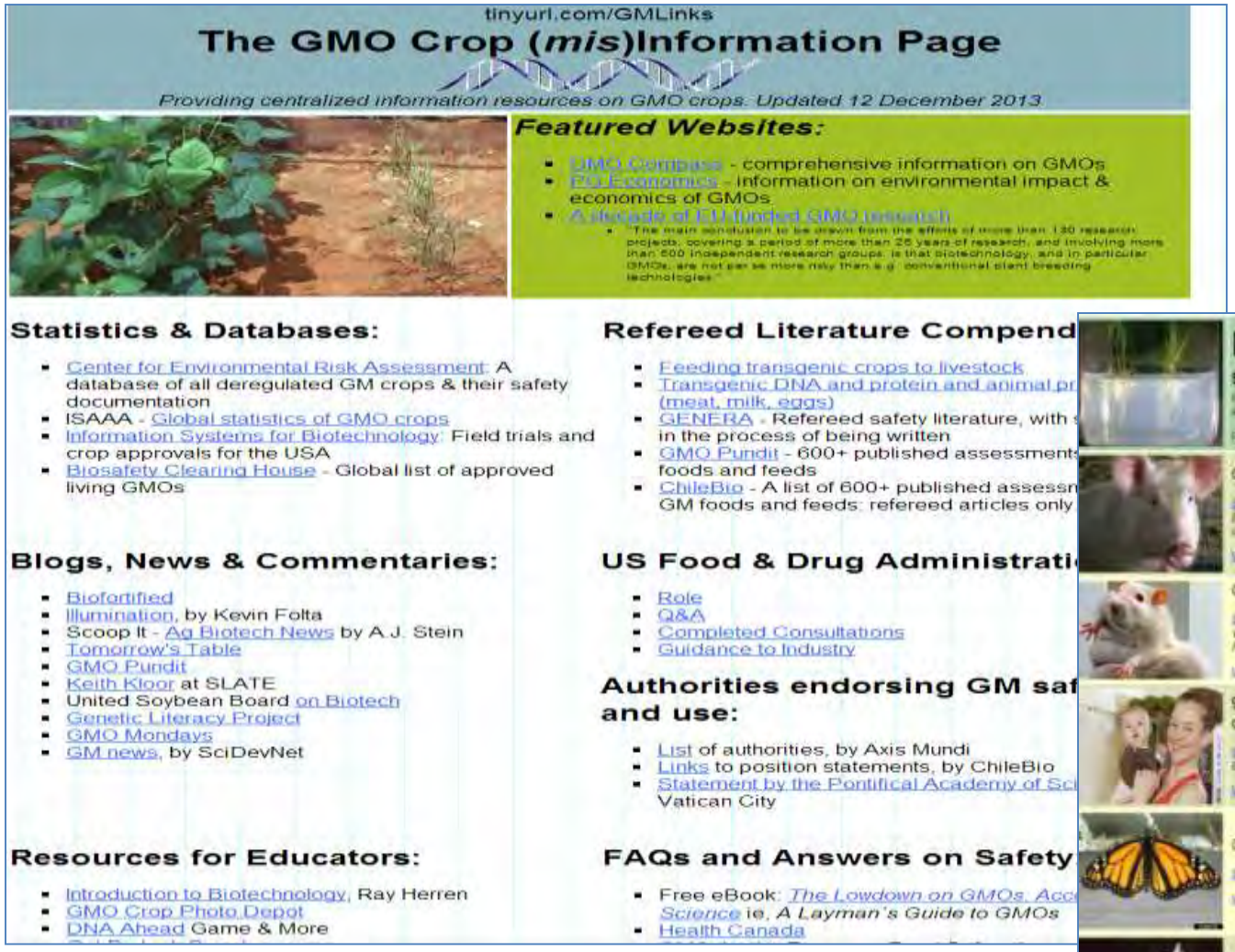
Prof Parrott / GMO crop information and misinformation web page



http://parrottlab.uga.edu/parrottlab/forum2.htm

The righteous

Corporate hyperbole

Complicity in unsustainable management

nature biotechnology

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NATURE BIOTECHNOLOGY | NEWS

Glyphosate resistance threatens Roundup hegemony

Emily Waltz

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"The number of weed species evolving resistance to glyphosate

Left vs. right senses of justice, social systems, roles for corporations, a major reason for outrage

- Profit vs. public good
- Socialist vs. capitalist
- Global vs. local food
- Monsanto vs. small farmers
- Patents vs. open source
- **Major reason for US vs. EU schism**

Are organically certified crops so “righteous” to warrant purity?

Gene flow is ubiquitous in agriculture – with or without GMOs

"Genetic drift" (i.e., seed and pollen movement) does not entitle Monsanto to take over your farm – nor do they try to!

Organic nor conventional is ideal: Coexistence needed

UNIVERSITY OF OXFORD

04 SEP

Organic farms not necessarily better for environment

Science

04 Sep 12

Organic cereals generate higher greenhouse gas emissions per unit of product than their conventionally farmed counterparts, the researchers found.

Organic farming is generally good for wildlife but
environmental impacts than conventional farming,
scientists has shown.

GENETIC LITERACY PROJECT
WHERE SCIENCE TRUMPS IDEOLOGY

The organic hepatitis outbreak: We need organic field testing

Mischa Popoff | June 17, 2013 | Genetic Literacy Project

Today's organic consumer is well informed. They have made the connection between quality of life and their own personal responsibility as for how it's going to play out for them. They understand the risks – the effects of

Many have become sick after eating organic frozen berries. (CREDIT: Flickr~Bob~Flickr)

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SEPT. 5, 2012

Little evidence of health benefits from organic foods, Stanford study finds

BY MICHELLE BRANDT

You're in the supermarket eyeing a basket of sweet, juicy plums. You reach for the conventionally grown stone fruit, then decide to splurge the extra $1/pound for its organic cousin. You figure you've just made the healthier decision by choosing the organic product — but new findings from Stanford University cast some doubt on your thinking.

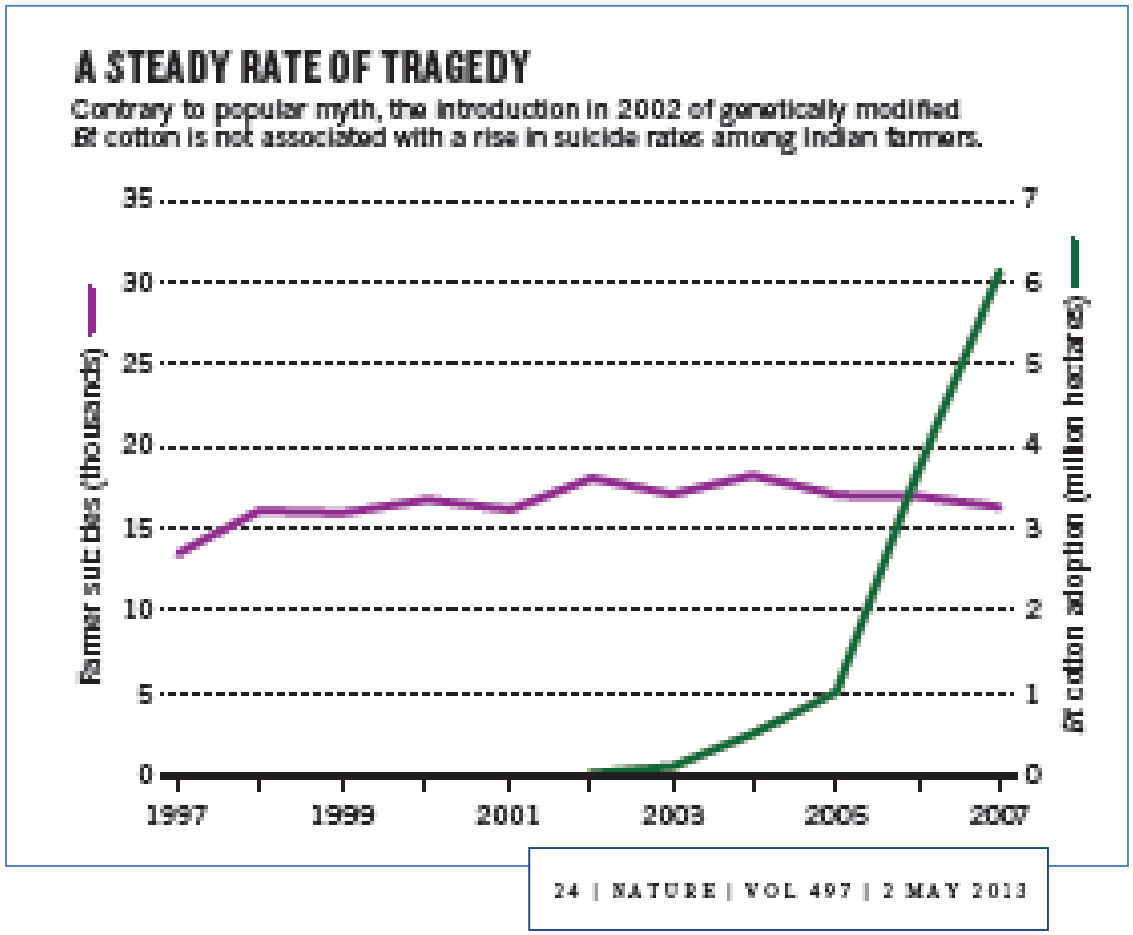
"There isn't much difference between organic and conventional foods. If you're an adult and making a decision based solely on your health," said Dena Bravata, MD, MS, the senior author of a paper comparing the nutrition of organic and non-organic foods, published in the Sept. 4 issue of *Annals of Internal Medicine*.

A team led by Bravata, a senior affiliate with Stanford's Center for Health Policy, and Crystal Smith-Spangler, MD, MS, an instructor in the school's Division of General Medical Disciplines and a physician-investigator at VA Palo Alto Health Care System, did the most comprehensive meta-analysis to date of

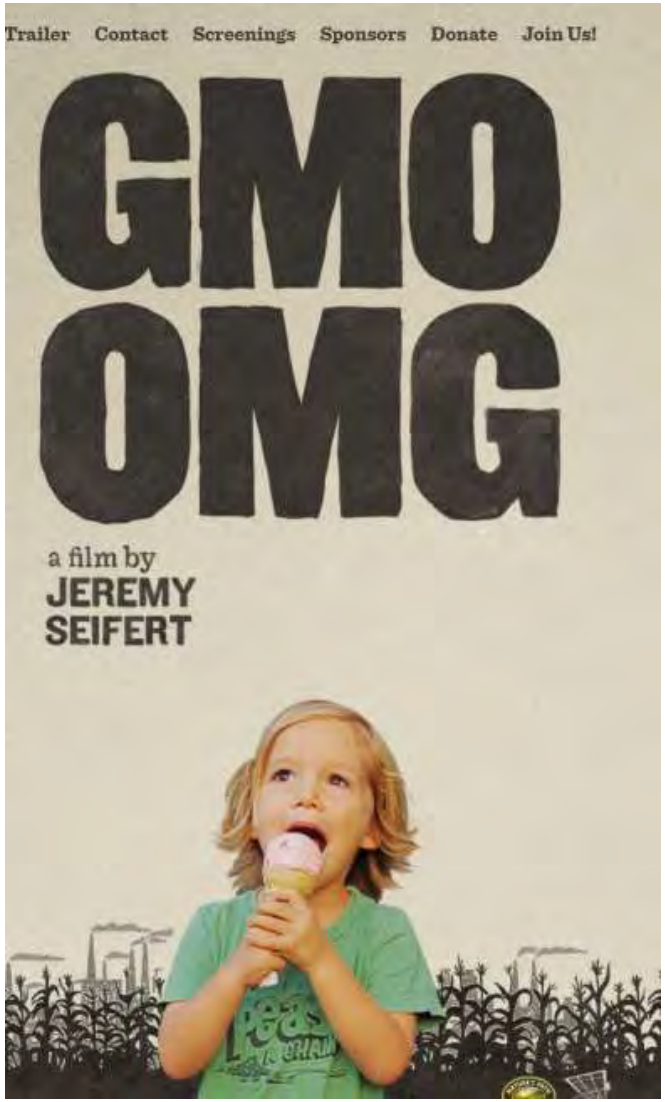
Crystal Smith-Spangler and her colleagues reviewed many of the studies comparing organic and conventionally grown food, and found little evidence that organic foods are more nutritious.

Abundant myths, amplified in righteous books, movies, and documentaries

Farmer suicides in India and GMO cotton among the most infamous



“Entertaining” documentaries



IS LABELING REALLY ABOUT OUR "RIGHT TO KNOW"?

"We are going to force them to label this food. If we have it labeled, then we can organize people not to buy it."

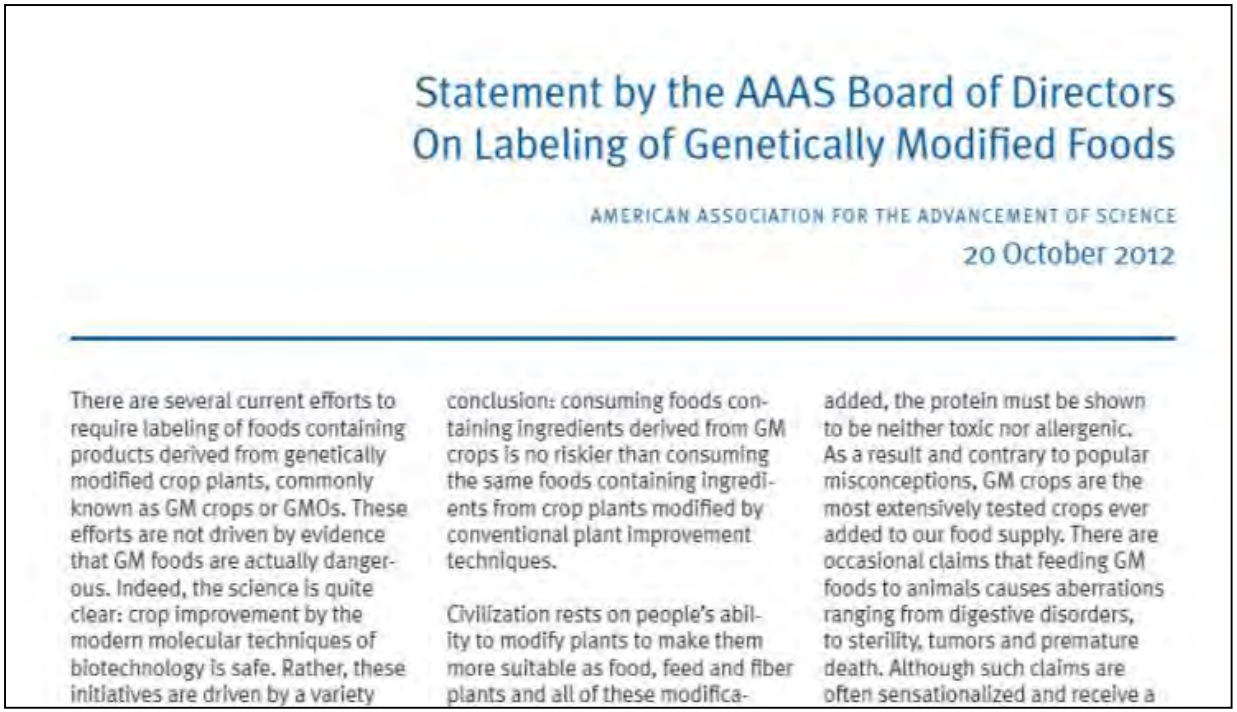
—Andrew Kimbrell, Executive Director, Center for Food Safety

"Personally, I believe GM foods must be banned entirely, but labeling is the most efficient way to achieve this. Since 85% of the public will refuse to buy foods they know to be genetically modified, this will effectively eliminate them from the market just the way it was done in Europe."

—Dr. Joseph Mercola, Mercola.com

Once examined seriously, labeling does not look so appealing – serious issues include science, cost, choice, and overall ethics

"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. There are occasional claims that feeding GM foods to animals causes aberrations ranging from digestive disorders, to sterility, tumors and premature death. Although such claims are often sensationalized and receive a

Approved by the AAAS Board of Directors on 20 October 2012

AAAS

Major newspapers agree

Tuesday, October 8, 2013 | TRAFFIC | 53°F

The Seattle Times
Winner of Nine Pulitzer Prizes

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IN THE NEWS: Boarding' mentally ill | Hazing expulsions | Government shutdown | Ocean acidification | Seahawks

Originally published Saturday, October 5, 2013 at 4:08 PM

Editorial: Vote No on Initiative 522, the GMO labeling initiative

Efforts to label foods with GMOs have failed in Oregon and California. Shoppers want useful information not scare tactics. Vote No on I-522.

Seattle Times Editorial

INITIATIVE 522 is a clumsy, emotion-based campaign to require labeling of selective food products containing genetically modified organisms.

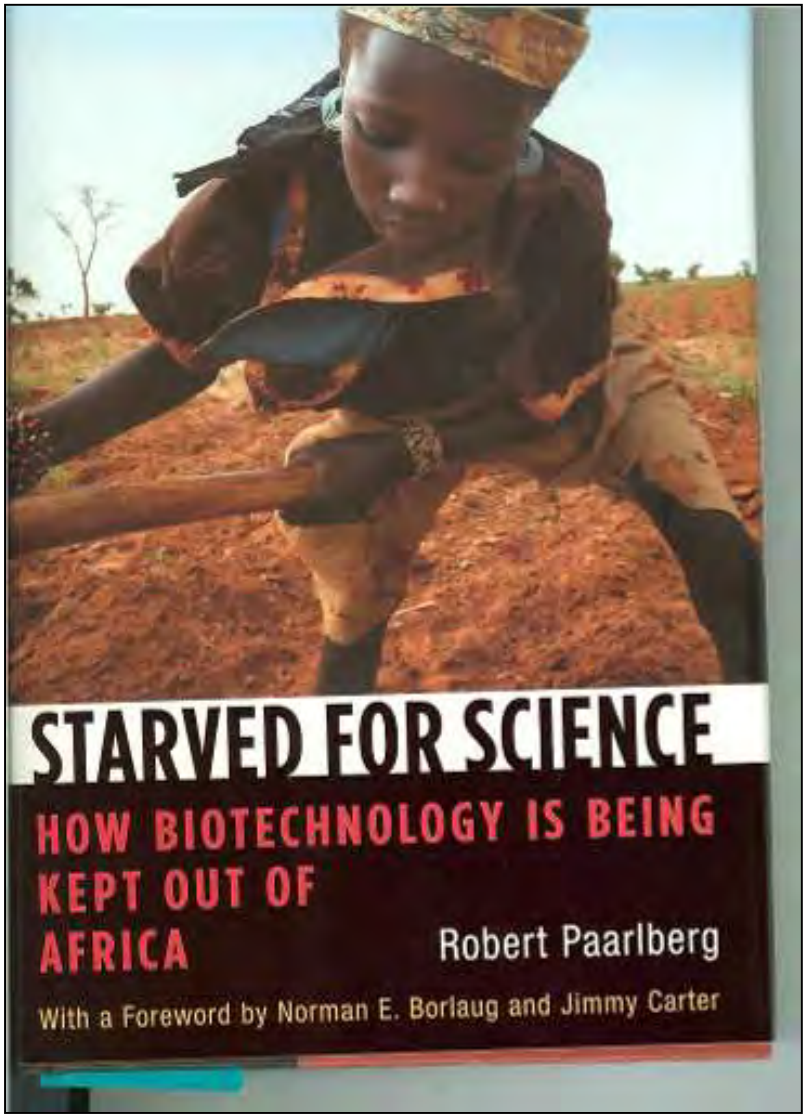
The issue for proponents of I-522 seems to be less about outcomes — the products themselves — but rather finding the modern processes offensive.

Farmers and science have nurtured and bred hybrid versions of plants and animals for selective characteristics for centuries. But the efforts of the last few decades have stirred critics whose alarmist concerns are not supported by the mainstream scientific community.

Multistate efforts to require labeling of products as containing genetically modified organisms are ostensibly about a bold warning on packaging. The intent is more pointed, if a bit more subtle.

Labeling is one part of an effort to make the use of GMOs more expensive, arduous and complicated for farmers, processors, shippers, inspectors and regulators.

Is it righteous to protect the developing world from GMO crops?



Golden rice and the Philippines

Vitamin A deficiency is a serious problem among the poor there. Field trials are underway to test, develop, and provide access to it for poor farmers

Intl Rice Research Inst: In the Philippines, vitamin A deficiency affects approximately 1.7 million children (15%) aged 6 months to 5 years

Subclinical vitamin A deficiency affects one out of every ten pregnant women

With funding and organization from European NGOs, field trials were vandalized in August 2013

Vandalism protested by >6,000 scientists

The New York Times

August 24, 2013

Golden Rice: Lifesaver?

By AMY HARMON

ONE bright morning this month, 400 protesters smashed

EDITORIAL

Standing Up for GMOs

newsblog

Nature brings you breaking news from the world of science

News & Comment › News Blog › Post

Swedish scientists decry government links to anti-GMO 'vandals'

13 Nov 2013 | 12:31 GMT | Posted by Davide Castelvecchi | Category: Biology & Biotechnology, Earth, environment & ecology, Policy

Posted on behalf of Marta Paterlini.

A group of Swedish scientists challenged their government in an open letter on 22 October in which they alleged that Swedish foreign aid has supported vandalism in the Philippines against research plots of genetically modified crops.

What have delays in use of Golden Rice cost?

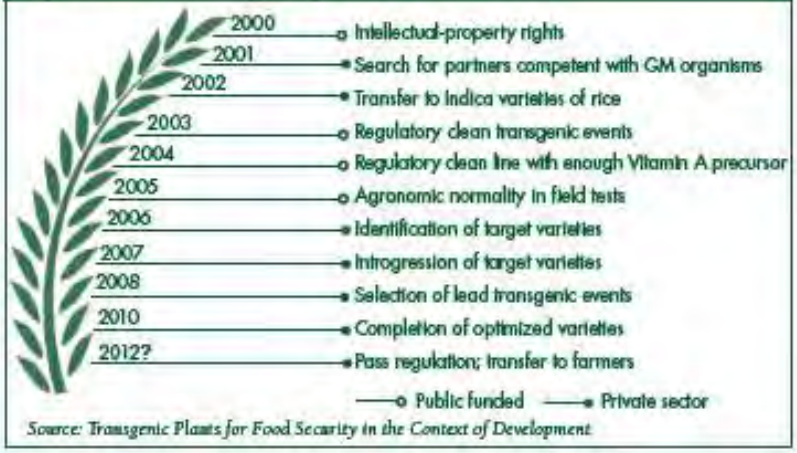
A crime against humanity to obstruct it?

Agricultural and Resource Economics
UPDATE
GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS • UNIVERSITY OF CALIFORNIA
V. 17 no. 3 • Jan/Feb 2014

The Cost of Delaying Approval of Golden Rice

Justus Wesseler, Scott Kaplan, and David Zilberman

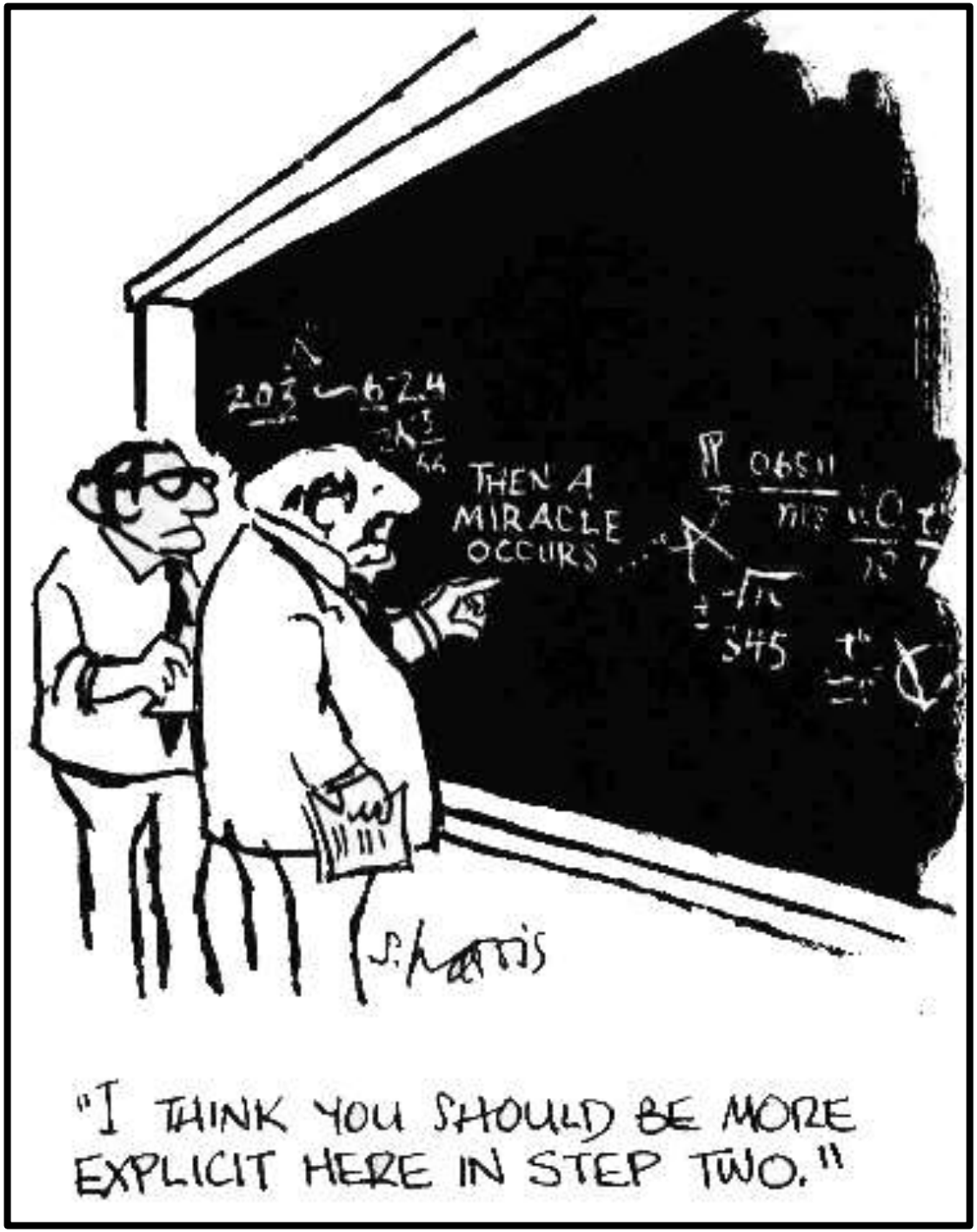
Figure 1. A Decade of Regulatory Hurdles for Golden Rice



Source: Transgenic Plants for Food Security in the Context of Development

<u>Cost of 10 years of regulatory (political) delays</u>

- ~$1 billion in lost productivity
- ~1 million cases of blindness
- Several-hundred thousand deaths



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Two big narratives to choose from

- Unethical, irreversible, and unpredictable impacts on food safety and environment
  - Stop it, label it, or otherwise regulate it to where it does not matter
- Studied and regulated smartly, it is an essential tool
  - For helping people in dire need right now, and for managing a very scary future on this planet