GMO crops

What they are, how are they regulated, and should food get a GMO label?

Steve Strauss
Oregon State University
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Pre-GMO: Crop domestication is the basis of agriculture, enabled civilization

Radical changes in domesticated animals too: All dogs derived from the wolf by non-GMO breeding









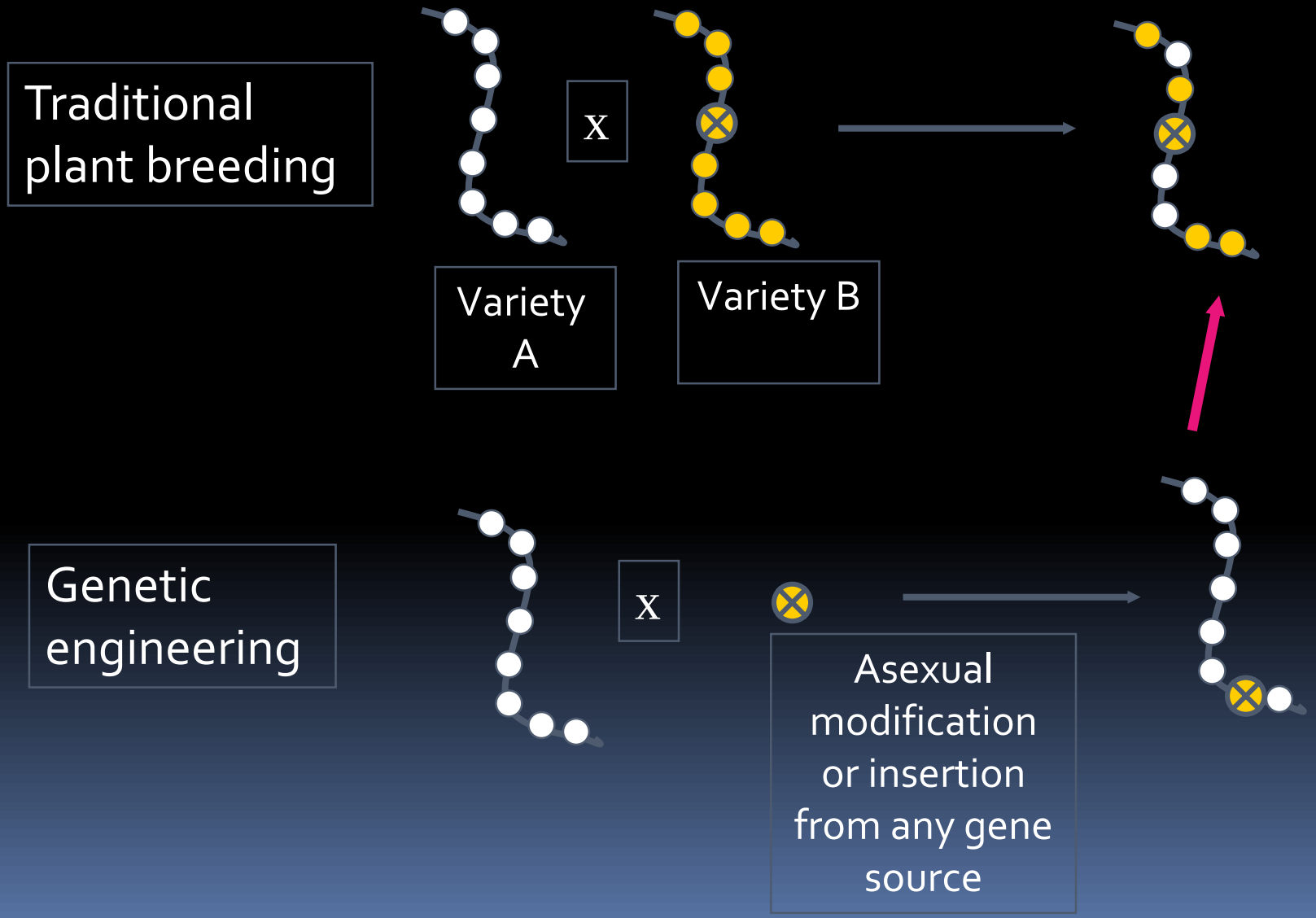




Non-GMO breeding continues and is accelerating in age of massive DNA sequencing

Genetic admixture is ubiquitous in agriculture – with or without GMOs

Genetic engineering defined



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 used interchangeably with GE or GM

Regeneration of GE plants (poplar)

Then propagated normally

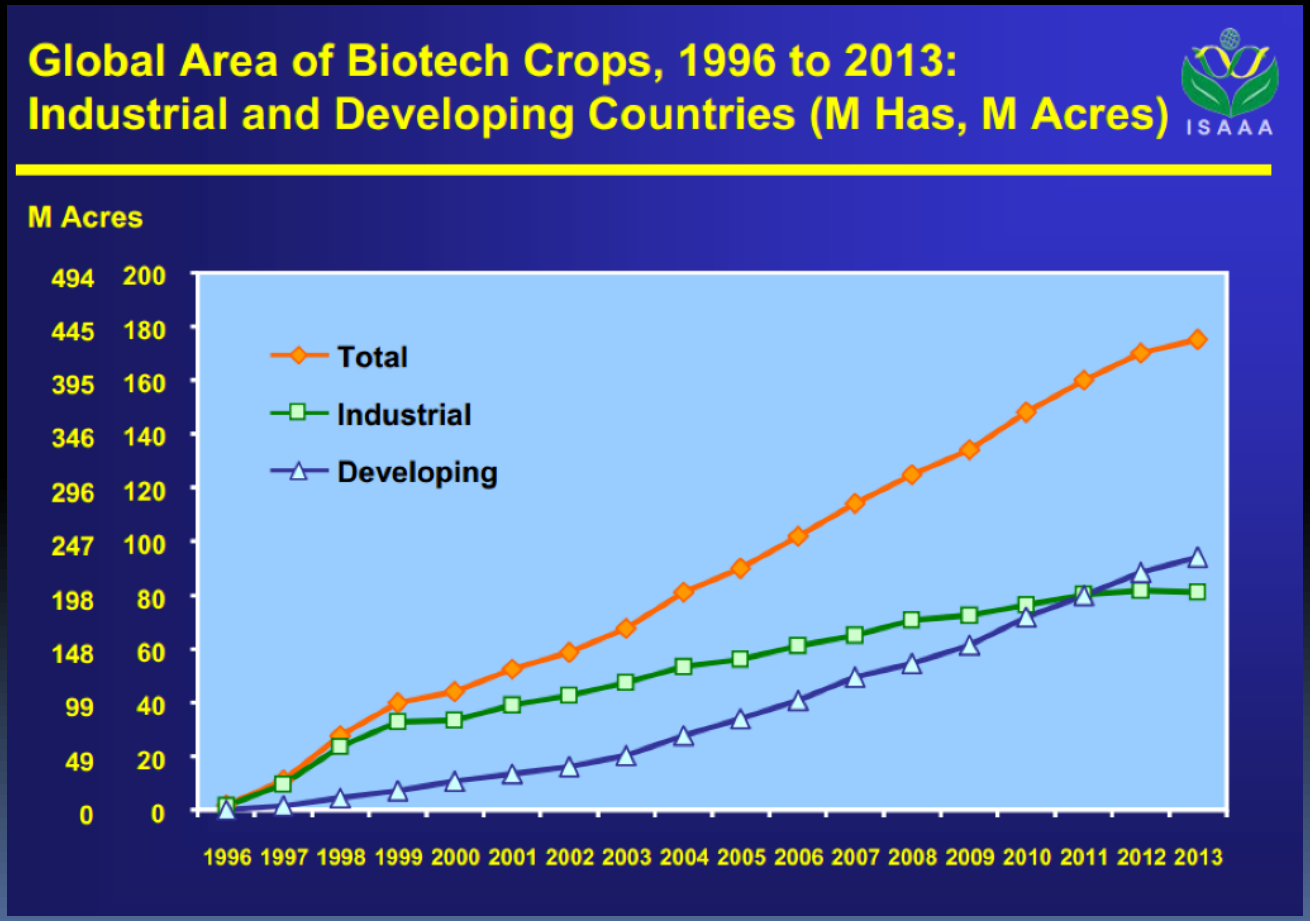
Seeds or cuttings tested for health and new qualities, incorporated into breeding programs

Propagation of poplars in tissue culture

Growth in the field

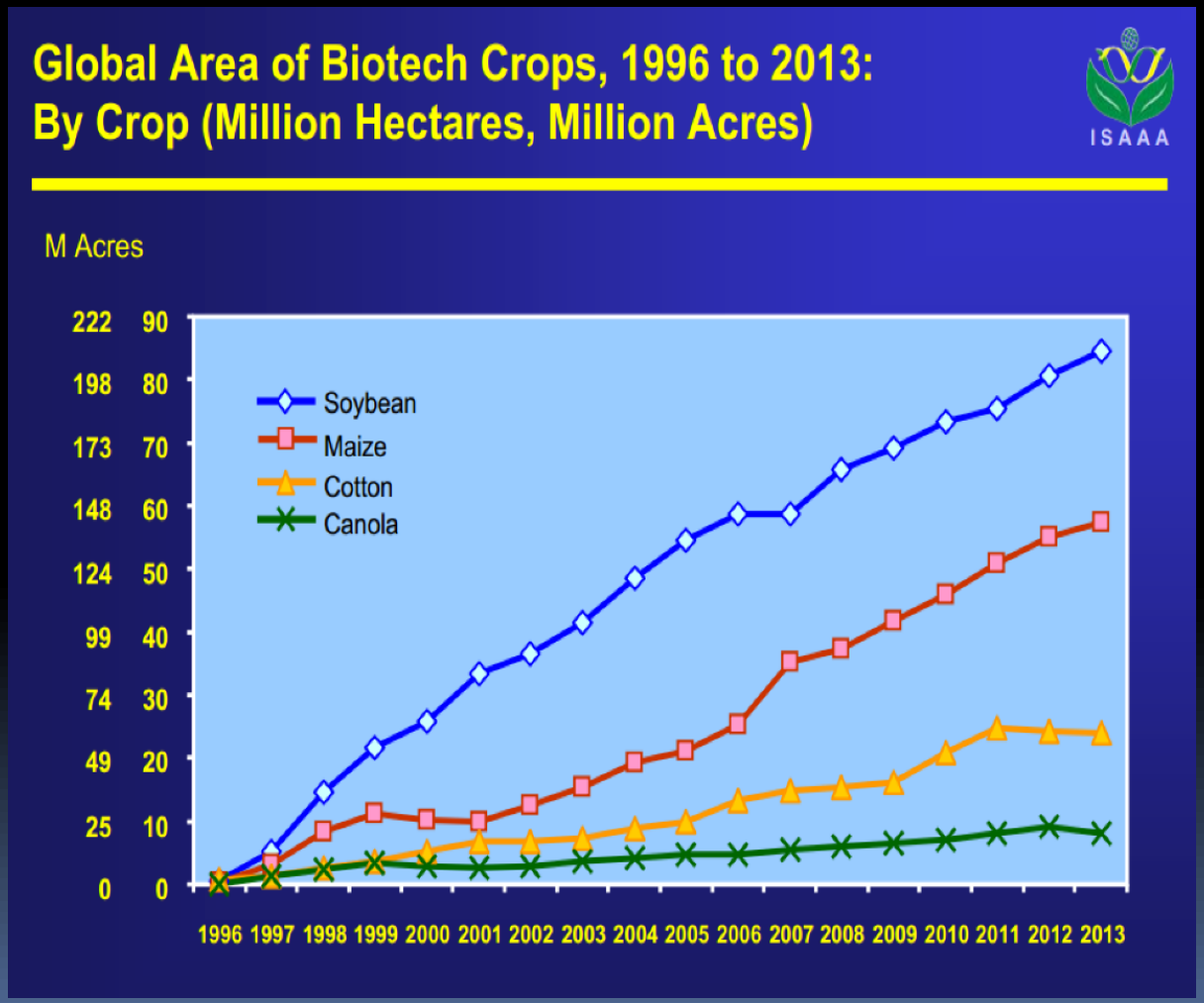
GMO crops widespread, rapidly adopted

Grown on >10% arable land on planet, extensive uptake in developing world



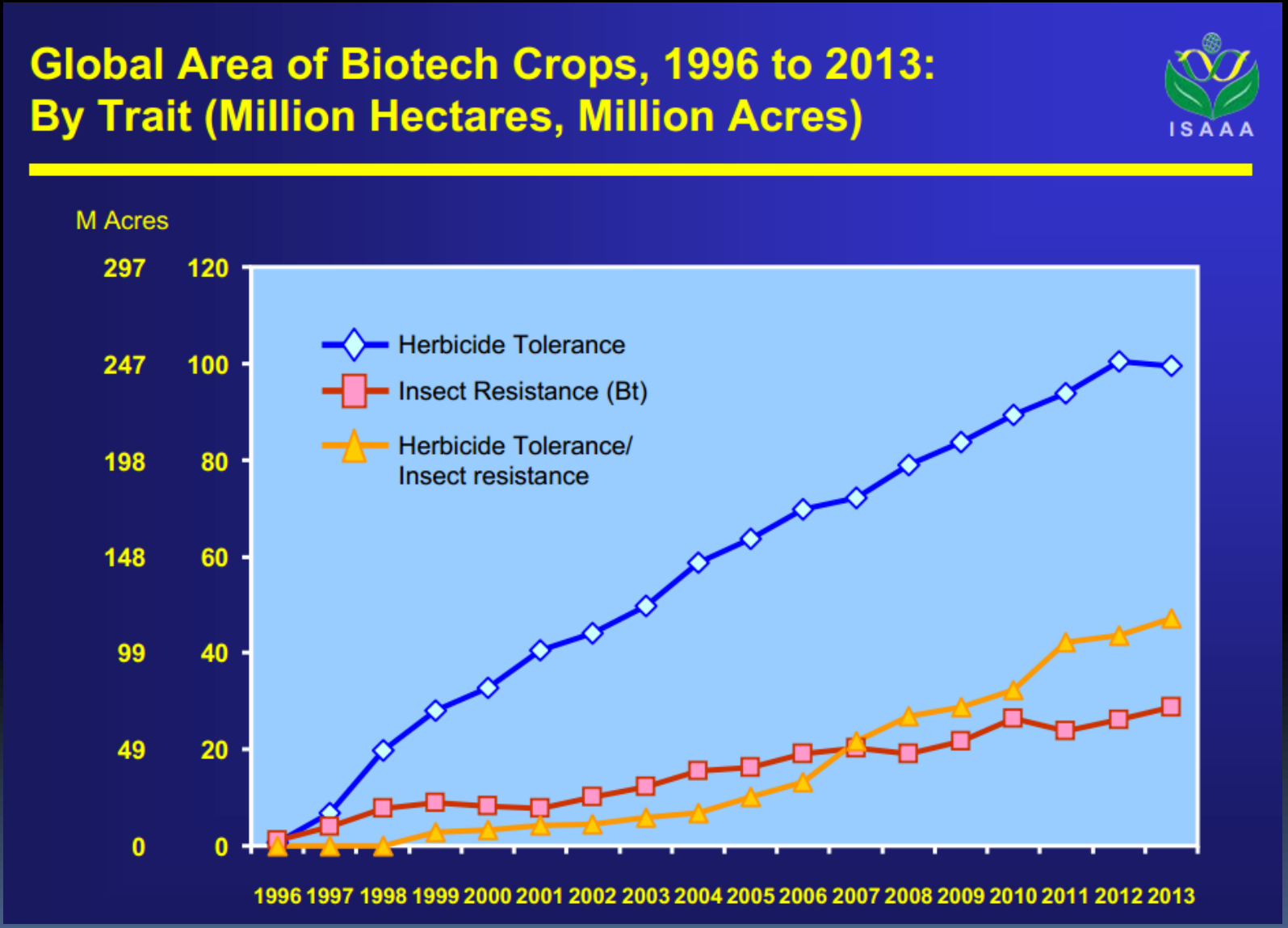
http://www.isaaa.org/resources/publications/briefs/46/pptslides/Brief46slides.pdf

Four crops dominate, 8 grown in USA



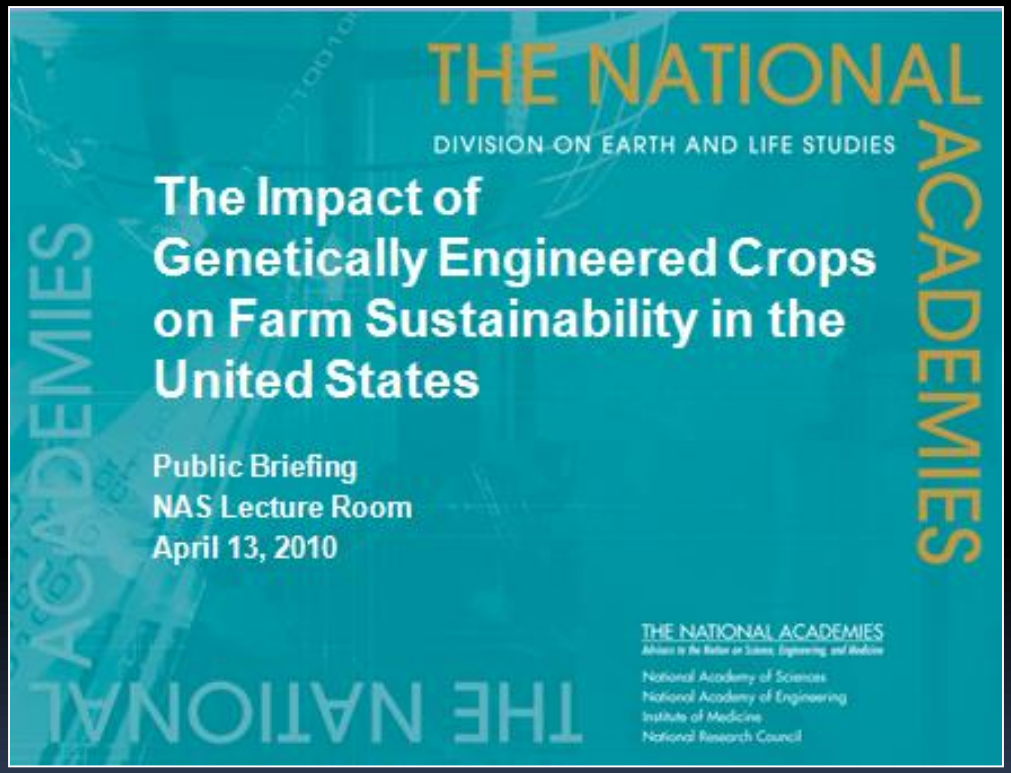
http://www.isaaa.org/resources/publications/briefs/46/pptslides/Brief46slides.pdf

Two traits dominate



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

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



REVIEWS IN ADVANCE

Review in Advance first posted online on August 14, 2013. (Changes may still occur before final publication online and in print.)

Agricultural Biotechnology: Economics, Environment, Ethics, and the Future

Alan B. Bennett,[1,2] Cecilia Chi-Ham,[2] Geoffrey Barrows,[3] Steven Sexton,[4] and David Zilberman[3]

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The *Annual Review of Environment and Resources* is online at http://environ.annualreviews.org

This article's doi: 10.1146/annurev-environ-050912-124612

Keywords

genetic modification, genetic engineering, GMO, GM crops, food security

Abstract

Agricultural biotechnology and, specifically, the development of genetically modified (GM) crops have been controversial for several reasons,

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 CO_2 emissions by ~27 billion kg, equivalent to ~13 million cars off the road
http://www.isaaa.org/resources/publications/briefs/46/topfacts/default.asp

Benefits provided by biotech crops, on a global scale: 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

There are legitimate science concerns that GMOs with pest management traits have not been managed well

THE TROUBLE WITH GMOs

AGAINST MY BETTER JUDGMENT, I'm dipping my toe into the genetically modified organism debate.

These are rough waters. GMOs seem to polarize people more than almost anything else — especially in terms of whether they are safe to eat or to grow. I try to stay open-minded on the topic, but it's obvious that the use of GMOs in agriculture has created some big problems.

The problem facing GMOs isn't with the technology per se; it's with how they have been deployed. Despite promises of improved food security, increased yields, decreased chemical use and more nutritious crops, GMOs end up causing many disappointing failures.

To begin, while GMO efforts may have started with good intentions to improve food security, they ended up focusing on crops that are better at improving profits, such as feed corn (mostly for animal feed and ethanol), soybeans (mostly for animal feed), cotton and canola. While the technology might have "worked," it wasn't applied to crops that actually feed the world's poor.

Furthermore, GMOs have had uneven success in boosting yields. Instead of improving plant growth, they have mainly replaced GMO crops, this was apparently more than offset by an increase in *herbicide* use on U.S. croplands, likely because weeds have become resistant to Roundup. Here there seems to have been a lack of systems thinking — which would have anticipated the "rebound" problems inherent in chemical weed control.

I also become skeptical when GMO approaches are pursued instead of simpler ways to address the same problem. For example, we hear a lot about biotech crops that are drought tolerant, fix their own nitrogen and so on, but they are a long way from being ready for the real world. Why not focus on agronomic approaches — such as using cover crops, mulching and organic-style techniques — instead, which could yield results *today*? Similarly, instead of engineering better nutrition into crops to make GMOs such as golden rice, why not grow conventional nutrient-rich crops such as fruits and vegetables? Why focus on more technical solutions, where a simple approach might be as (or more) effective?

Finally, many GMO advocates bristle at efforts to require labeling of GMO food because they see "no substantial biological difference" between GMO and traditional crops. Maybe, but that's not the point. It's

thinking, where the focus is on technology and business models, and less on the social and environmental impacts.

I urge GMO advocates to take a step back and think more *holistically* about GMO technologies in the context of the larger systems connecting agriculture, food, culture, people and the environment. I encourage them to build more *interdisciplinary* research teams — with social scientists, ecologists, organic farmers and GMO critics. I suggest supporting more of their work with public funding, to help ensure that social and environmental benefits are put ahead of profits. And I would strongly urge *both* sides of the GMO debate

GMOs have frequently failed to live up to their potential, not because they are inherently flawed, but because

ensia

SPRING 2014 | ENVIRONMENTAL SOLUTIONS IN ACTION

GMOs have frequently failed to live up to their potential, not because they are inherently flawed, but because **they have been poorly deployed into the complex social and environmental contexts of the real world.**

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

nature biotechnology

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

NATURE BIOTECHNOLOGY | NEWS

Glyphosate resistance threatens Roundup hegemony

Emily Waltz

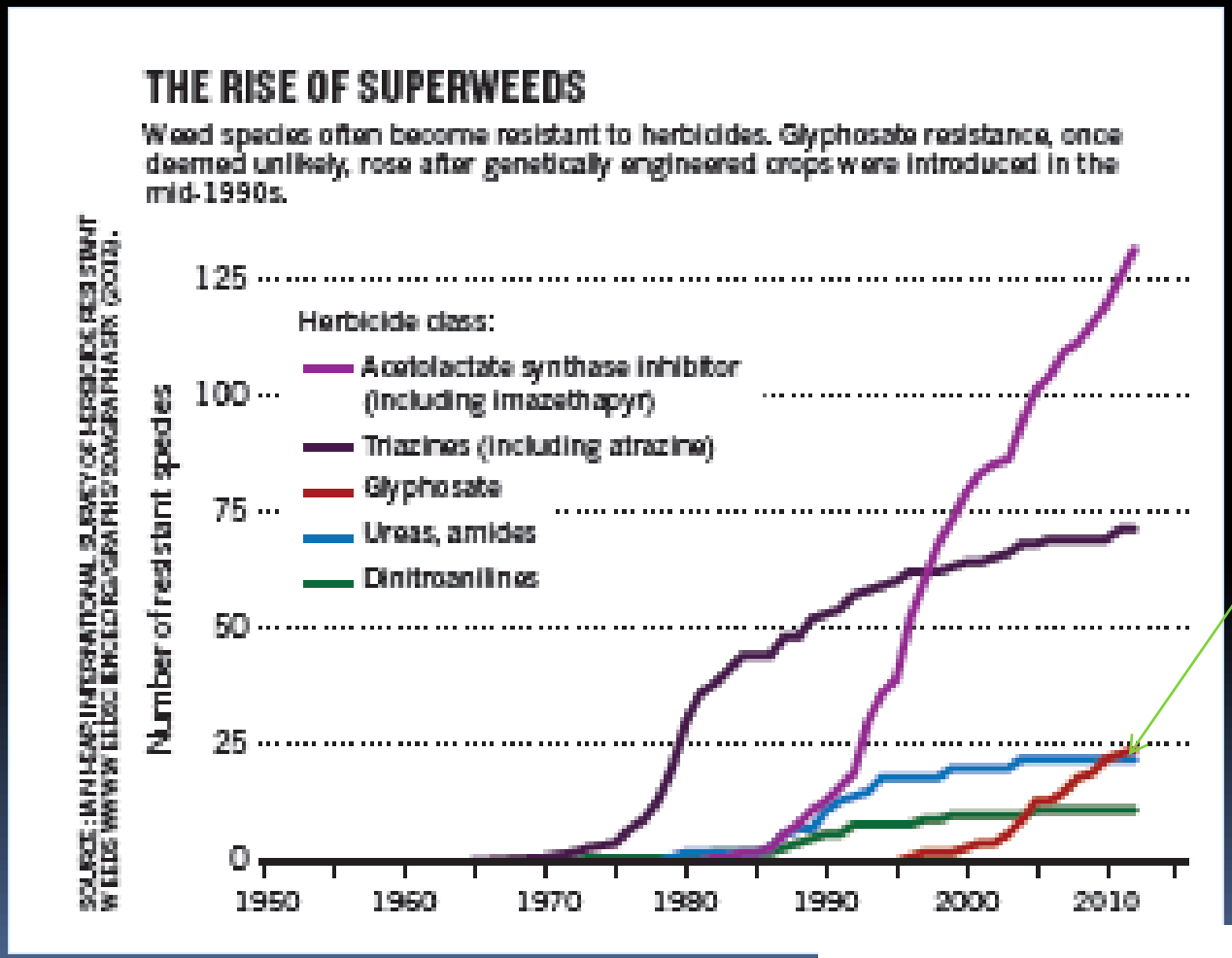
Nature Biotechnology **28**, 537–538 (2010) | doi:10.1038/nbt0610-537
Corrected online **13 October 2010**
Corrigendum (October, 2010)

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.

BILL BARKSDALE / AGSTOCKUSA /

"The number of weed species evolving resistance to glyphosate

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

The method has diverse applications

Many other crops and traits starting to be used, or in the pipeline for near term use

Virus-resistant papaya saved the Hawaiian industry in the mid-1990s / ~80% of papaya today

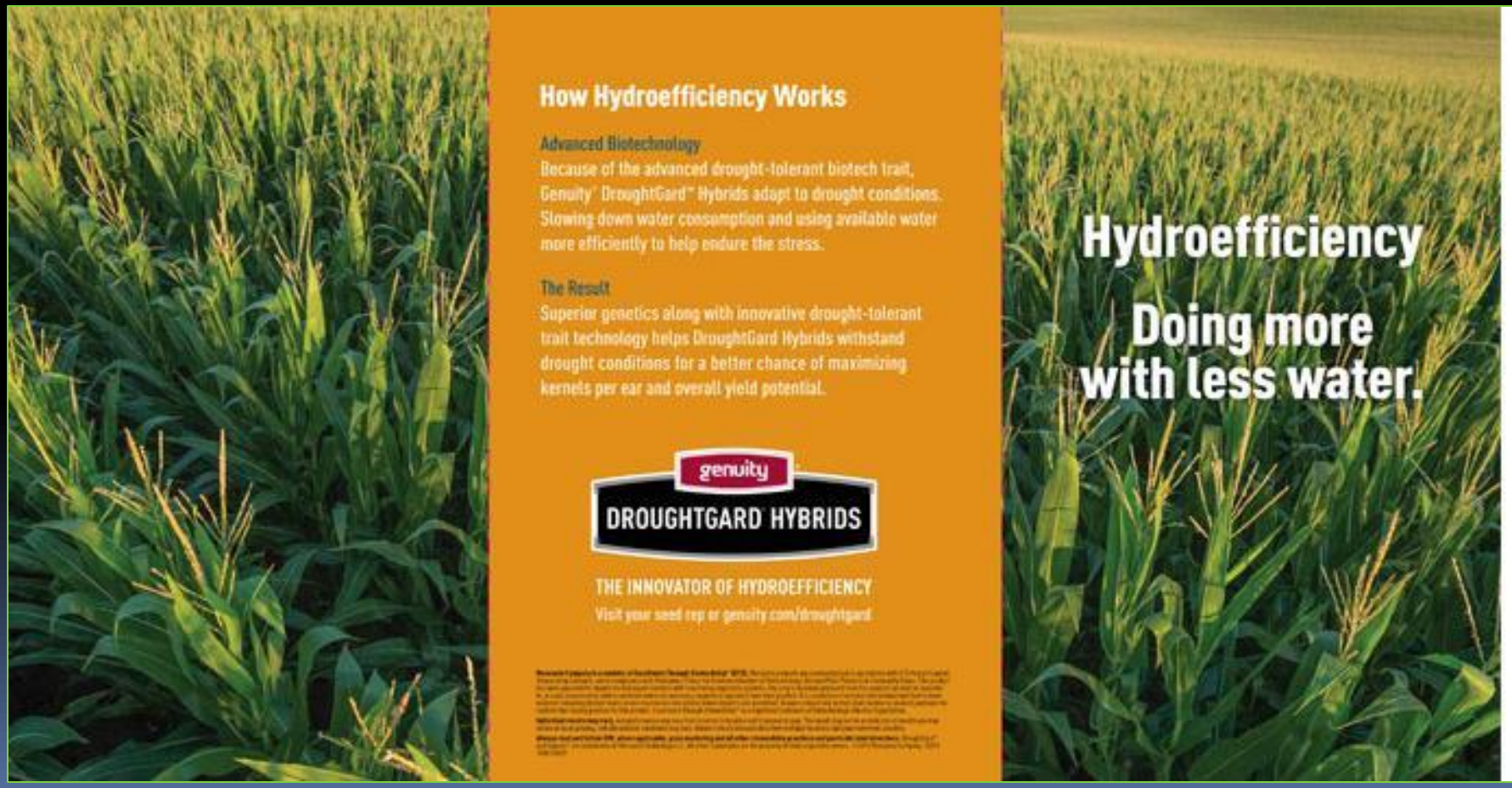
- Nobel prize winning "immunization" in plants – **stimulates natural defenses**
- Great humanitarian potential in developing world

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

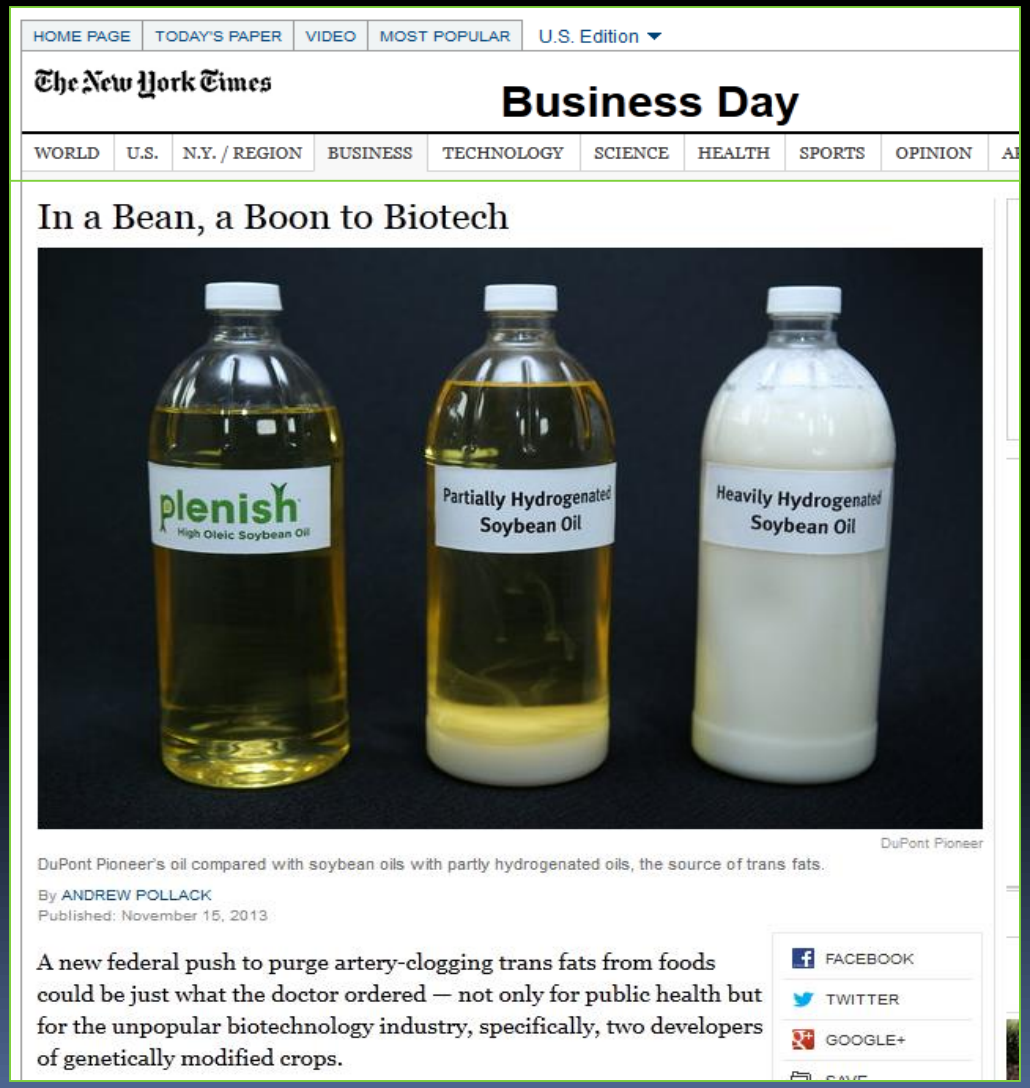
Current Biology 23, 1094–1100, June 17, 2013 ©2013 Elsevier Ltd All rights reserved http://dx.doi.org/10.1016/j.cul

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].

Healthier soy oils: High oleic acid and omega-3



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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
TWITTER
GOOGLE+

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

Healthier potato – reduced browning and acrylamide (↓waste, ↑safety)

Trait #1 - Silenced PPO (Enzyme)

- Non-browning when cut
- Reduced black spot bruise

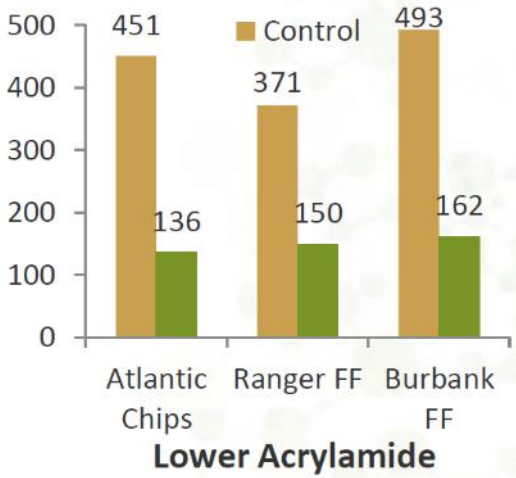
Trait #2 - Reduced Asparagine (Amino Acid)

- 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

Helping forests under threat by exotic pests

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The American Chestnut's Genetic Rebirth

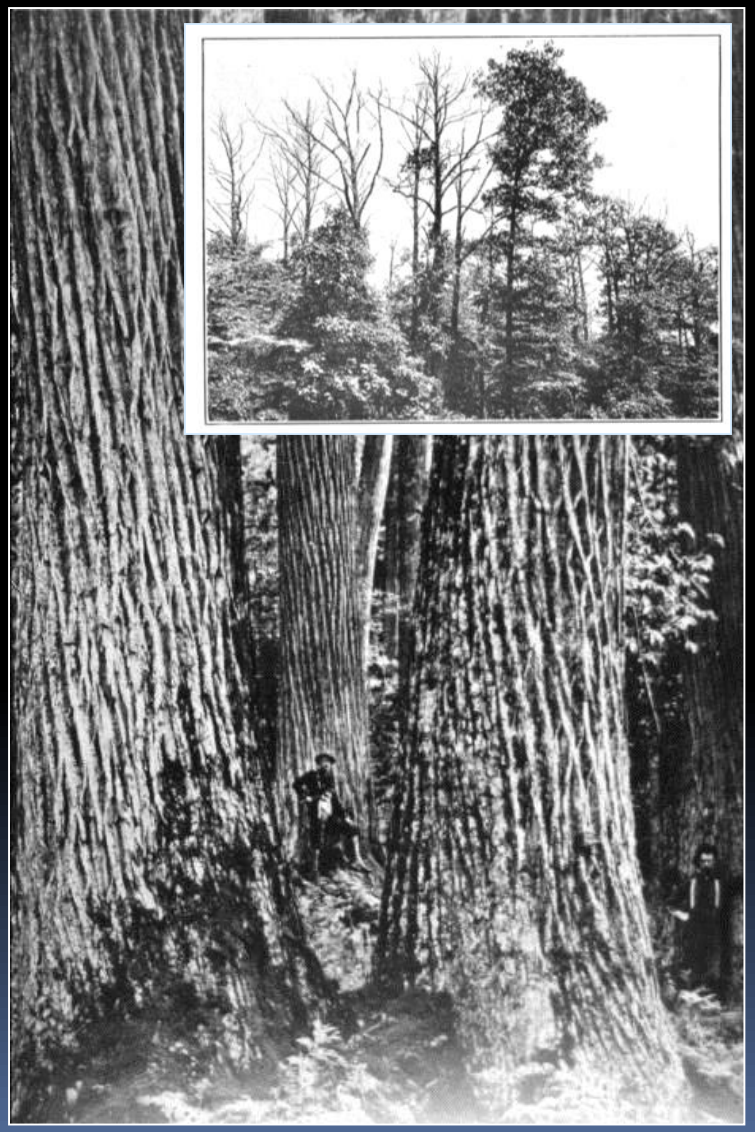
A foreign fungus nearly wiped out North America's once vast chestnut forests. Genetic engineering can revive them

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

Vitamin enrichment for the poor – to help billions that are malnourished

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.

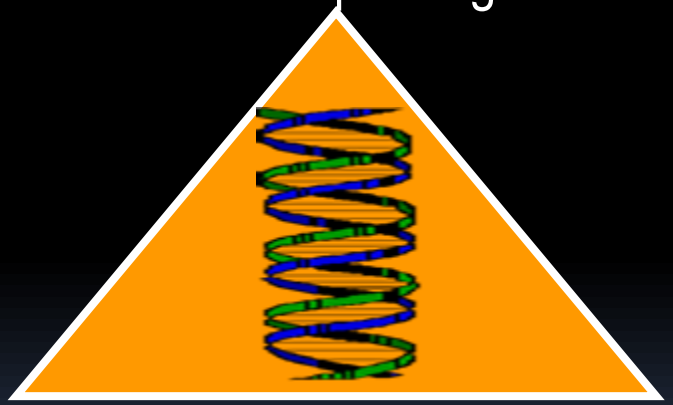
This is epxected to help improve nutrition for nearly 300 mn people in Africa dependent on Sorghum. DuPont said that the ability to achieve 100 % of the recommended daily allowance of vitamin A in children from Sorghum has never been achieved before.

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

Regulated at the federal level in the USA – three agencies based on the trait and prior laws

USDA – US Dept of Agriculture



EPA - Environmental Protection Agency

FDA - Food & Drug Administration

By far the most carefully studied crops for safety – no question

- Of 129 GE crops commercialized in the US and 129 have had FDA consultation
  - EPA and/or USDA also do evaluations for most types of crops
- Foreign regulatory bodies repeat and verify most safety assessments
  - Health Canada, FSANZ, EFSA, Korea FDA, EFSA, Chinese Ministry of Agriculture, Japan Food Safety Commission

Components of pre-market safety assessment

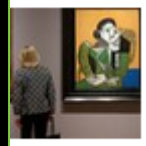
- Characterization of inserted DNA and insertion sites
- Characterization and toxicology of newly introduced proteins
- Detailed composition analysis
- Optional whole food animal studies
- Search for unintended adverse effects such as introduction of toxins, anti-nutrients, introduction of an allergen or changes in allergenicity

Mainstream science strongly supports safety for humans

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

Vermont labeling law passed – but in legal limbo amidst lawsuits

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

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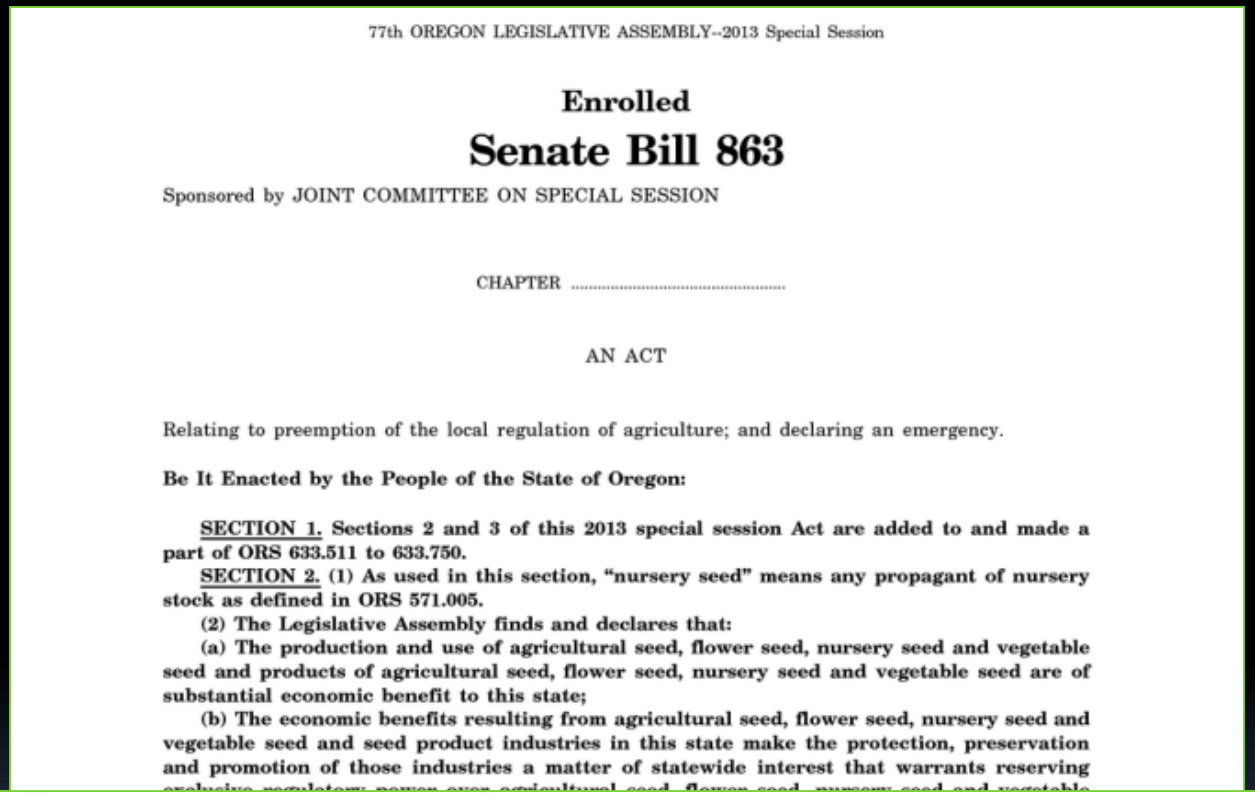
TWITTER
SAVE
MORE

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.

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;

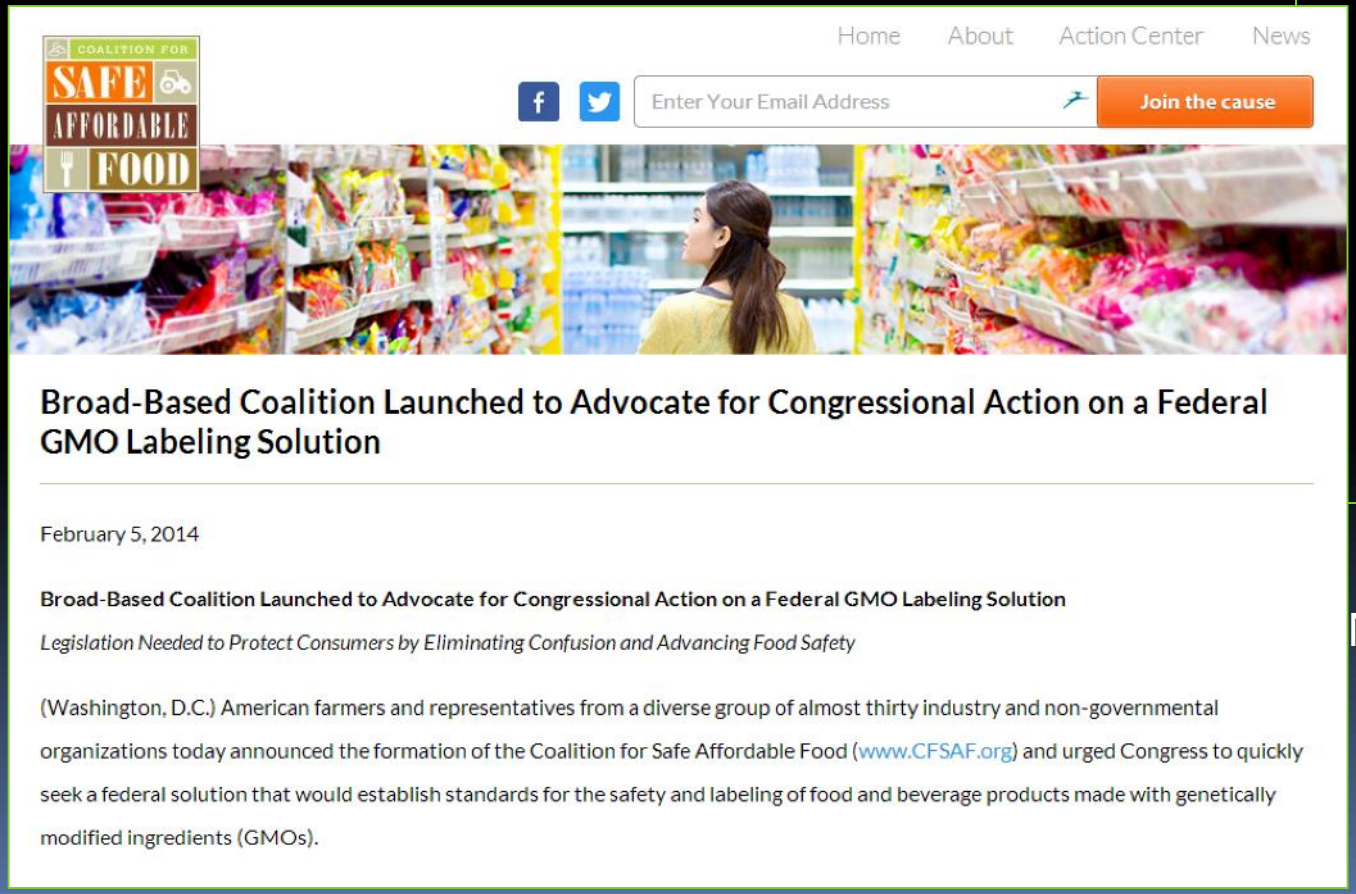
(b) The economic benefits resulting from agricultural seed, flower seed, nursery seed and vegetable seed and seed product industries in this state make the protection, preservation and promotion of those industries a matter of statewide interest that warrants reserving

(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.

Effort underway to standardize and prohibit "Balkanization" of GE label 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



Should GMO-crop derived food have a mandatory label, vs. the common voluntary non-GMO labels (organic, non-GMO)?

BE IT ENACTED BY THE PEOPLE OF THE STATE OF OREGON:
AN ACT REQUIRING THE LABELING OF GENETICALLY ENGINEERED RAW AND PACKAGED FOOD

Section 1. Findings and Declarations

(1) Oregon consumers have the right to know whether the foods they purchase were produced with genetic engineering so they can make informed purchasing decisions. Labeling is necessary to ensure that Oregon consumers are fully and reliably informed about the products they purchase and consume. Labels provide informed consent and prevent consumer deception. Polls consistently show that the vast majority of the public wants to know if its food was produced with genetic engineering, for a variety of reasons.

(2) For multiple health, personal, economic, environmental, religious, and cultural reasons, the State of Oregon finds that food produced with genetic engineering should be labeled as such, as evidenced by the following.

(3) In the United States, there is currently no federal or Oregon State requirement that genetically engineered foods be labeled. In contrast, sixty-four countries, including Japan, South Korea, China, Australia, Russia, India, the European Union member states, and other key U.S. trading partners, already have laws mandating disclosure of genetically engineered foods on food labels. In 2011, Codex Alimentarius, the food standards organization of the United Nations, stated that governments are free to decide on whether and how to label foods produced with genetic engineering.

(4) The U.S. Food and Drug Administration (FDA) does not require or conduct safety studies of genetically engineered foods. Instead, any safety consultations are voluntary, and genetically engineered food developers may decide what information to provide to the agency. Market

Pros vs. cons of mandatory GMO labels

- Pro viewpoints
  - Right to know
  - Tool to track problems
  - Ethics (keep animal DNA out of food of vegetarians)
  - Many other countries are doing it
  - Restrict - stigmatize – increase costs of using GMOs

Adapted from: http://www.ext.colostate.edu/pubs/foodnut/09371.html

Pros vs. cons of mandatory GMO labels

- Con viewpoints
  - Already intensively regulated/scrutinized already by US government, far more than conventionally bred crops
  - We have a labeling law already in place (FDA) for changes that matter ("material" changes to nutrition, safety, whether positive or negative)
  - Organic already GMO-free and widely available to consumers who wish to choose non-GMO for any reason

Adapted from: http://www.ext.colostate.edu/pubs/foodnut/09371.html

Pros vs. cons of mandatory GMO labels

- Con viewpoints
  - A prominent and mandatory label has been shown in scientific studies to mislead/scare/stigmatize consumers (viewed as warning label)
  - Labeling increases cost of food for all consumers (estimates vary, but some estimates are very high). This is unethical because it hits the poor hardest
  - Reduces choice by loss of GMO products, as has been observed in Europe (food system cannot infrastructure cannot support GMO and non-GMO options for most foods, and companies often avoid stigma to their brand label so don't use GMO)

Adapted from: http://www.ext.colostate.edu/pubs/foodnut/09371.html

Those who fund and write labeling ballot measures are interested in removing GMO technology

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

The largest organization of scientists in the USA and the world – AAAS – does not support labels

"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

ADVANCING SCIENCE, SERVING SOCIETY

The Oregonian editorial board, and those of most other mainstream news organizations, have not supported labeling measures

OPINION

Contact: Editorial: 503-221-8150 • commentary@oregonian.com • letters@oregonian.com

GMO food-labeling mandate would only sow confusion

Backers claim labels on GMO products will prevent consumer confusion, but the exact opposite is likely to be true

Backers of an initiative that would require labels for food produced using genetic engineering turned in more than 155,000 signatures this week, virtually guaranteeing a spot on the November ballot. Similar initiatives having failed in California in 2012 and in Washington in 2013, it's now Oregon's turn on the label-it movement's West Coast swing. With any luck, voters here will do justice to the state animal, the beaver, commonly known as nature's engineer.

Editorial

What is a GMO at an LA farmers market

- http://www.youtube.com/watch?v=EzEr23XJwFY

Arguments for measure 92
GMOs are increasing use of toxic pesticides

- Herbicide-resistant weeds have increased due to use of herbicide tolerant GMO crops
  BUT
- Total herbicide toxicity appears to have decreased or remained the same
- Low- and no-till agriculture has increased due to these GMO crops, with many environmental benefits
  - Reduced greenhouse gas release and soil erosion; increased soil carbon and wildlife habitat

Arguments against measure 92
Its about method, not content of food

- It stigmatizes one method of genetic modification among many – when there is clear scientific consensus that its “product not process” that matters
  - USA National Academy of Sciences: “There is no evidence that unique hazards exist either in the use of rDNA techniques or in the movement of genes between unrelated organisms.”
- Clearly safer products, such as more healthy corn and potato, will be “warning labeled” too

Arguments against measure 92
It is of no value for making health decisions

- It does not account for different types or amounts or activities of GMO materials in food
- It requires labels on GMO gene & protein-free materials – like oils and sugars
- Much of the food we eat is exempted from any sort of labeling (e.g., restaurants, cafeterias, meats)

Arguments against measure 92

We have reliable, standardized, national GMO-free choices

- Organic food is now common and cannot be made with GMO ingredients
- The GMO-free label is rapidly growing, and is more rigorous for those with concerns (e.g., meats from GMO-fed animals are excluded)
- The costs are not imposed on others, they are borne by those with strong concerns

Arguments against measure 92
The cost of food will be increased, disproportionately hurting the poor

- Main costs are segregation, tracking, and compliance inspection, not printing
- Recent studies from Cornell University and the Washington Academy of Sciences suggest it may be hundreds-$$ per family
  - Oregon administrative cost alone in millions/yr
- The stigma of the prominent label is likely to prompt many producers to use higher priced, non-GMO ingredients – raising food prices
  - Ben and Jerry's now trying – 5-20% (Wall St. Journal)
  - Reduced choice? Companies likely to discontinue many products just for Oregon

Arguments against measure 92

Investments in consumer education by labeling should start with issues of highest consumer and health concern

Food Safety Concerns

- Disease/contamination and handling/prep are still the most mentioned food safety concerns, although to a lesser degree than previous years.

Food safety concerns	Total 2014 (A)	Total 2012 (B)	Total 2010 (C)	Total 2008 (D)
	n=1000	n=751	n=750	n=1000
Disease/contamination	18%	29% A	29% A	38% ABC
Handling/preparation	18%	21%	23% AD	17%
Preservatives/Chemicals	12% D	13% CD	8% D	6%
Agricultural production	10% CD	7%	7%	5%
Packaging/labeling	9% BCD	5% D	4%	2%
Health/nutrition	7% D	8% D	6%	4%
Biotech	7% BCD	2%	2%	1%
Food sources	6%	7%	8%	9% A
Processed foods	3% BCD	1%	1%	1%
Other	3% CD	1%	1%	<1%

A/B/C/D indicate statistical significance between years

Q12. What, if anything, are you concerned about when it comes to food safety? [OPEN END]

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http://www.foodinsight.org/sites/default/files/FINAL%20Full%20Report_IFIC%202014%20Food%20Tech%20Survey.pdf

Arguments against measure 92

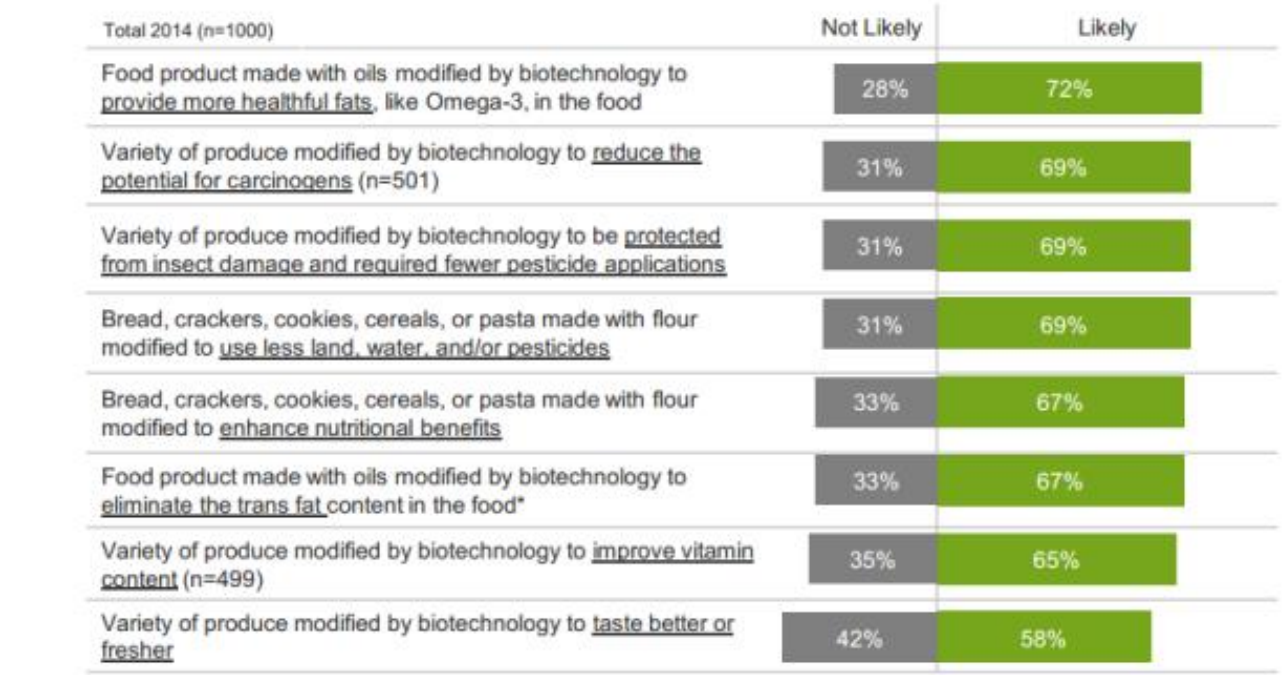
The stigma and cost will impede future biotechnology innovations, against American's interests

- Regardless of benefits, it will be risky for companies to produce products with a marketplace stigma and added cost
- Investment in R & D will decline
- New crops in the commercial pipeline with clear benefits may be abandoned, and new innovations left on the shelf

Poll: A majority of Americans wish to purchase products of biotechnology

Likelihood to Purchase Plant Biotech Foods

- Consumers show high interest in nutrition & health-related benefits of food biotechnology.
- Nearly three-quarters of Americans say they are likely to purchase foods made with oils modified to provide more healthful fats, such as Omega-3s.



*Note: Wording change from 2012 - "reduce the saturated fat content"
A/B indicate statistical significance between years
PB5. Q25 Q22 Q23. All other things being equal, how likely would you be to buy...

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http://www.foodinsight.org/sites/default/files/FINAL%20Full%20Report_IFIC%202014%20Food%20Tech%20Survey.pdf