



# **GMO crops**

## **The science vs. the controversy**

**Steve Strauss**

Oregon State University

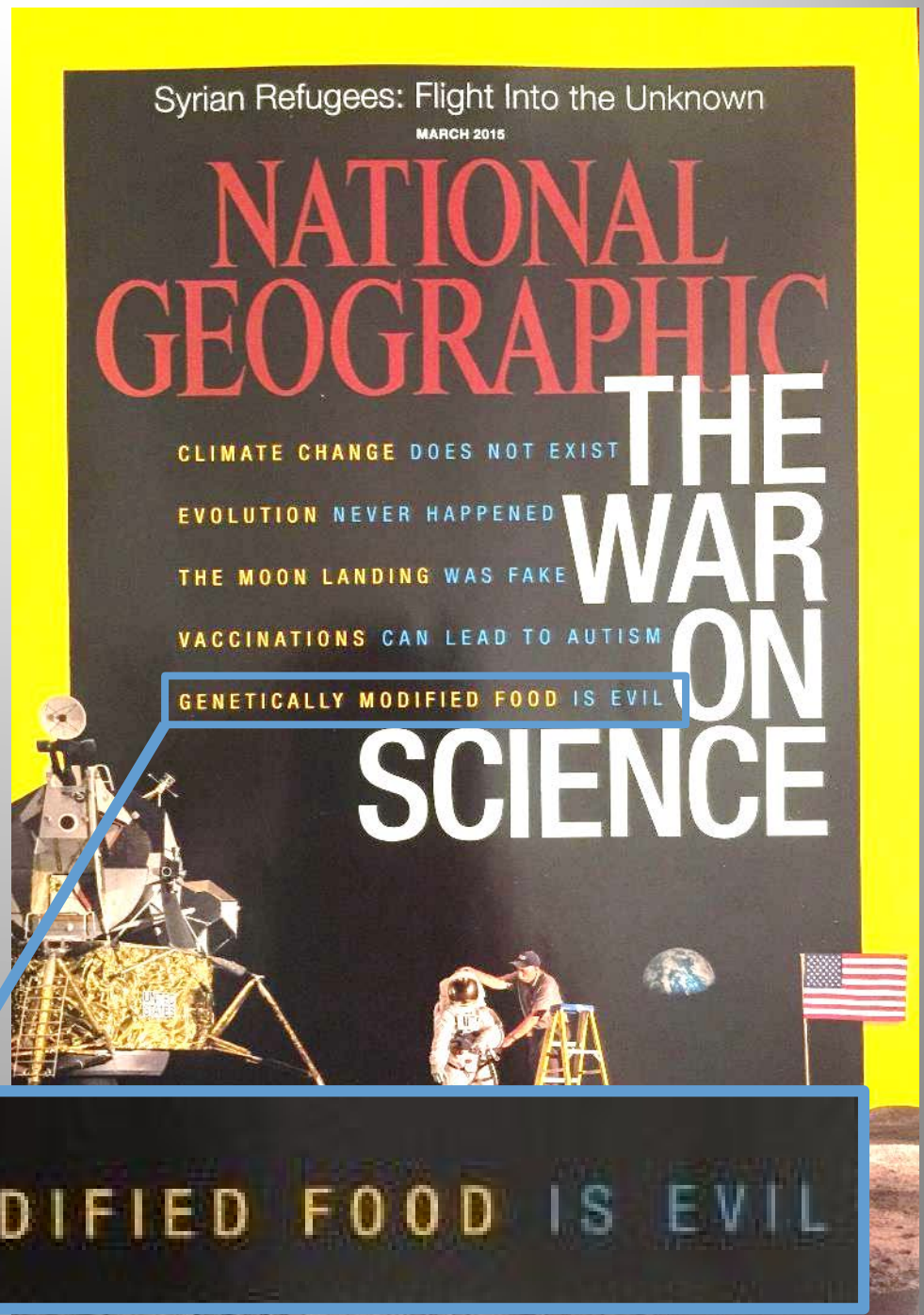
[Steve.Strauss@OregonState.Edu](mailto:Steve.Strauss@OregonState.Edu)

# Why do GMOs matter to you?

- Conflicting information about them is widespread – I want **truth**
- Not being **duped** by **costly** but unfounded greenwash and natural food claims
- Wish to see **wise use of a critical technology** for food, medicine, and energy production
- Urgent issue for the **poor** and under a **changing climate**

Fake news and  
fake science is  
widespread

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



GENETICALLY MODIFIED FOOD IS EVIL

# AAAS: Position on GMO labeling

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

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

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE  
20 October 2012

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

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

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

added, the protein must be shown to be neither toxic nor allergenic. As a result and contrary to popular misconceptions, GM crops are the most extensively tested crops ever added to our food supply. The occasional claim that GM foods are harmful to animals, ranging from digestive problems to sterility, tumor growth, and death. Although such claims are often sensationalized and receive a

Approved by the AAAS Board of Directors on 20 October 2012





# GMO warning labels common



# Vicious anti-GMO messages widespread





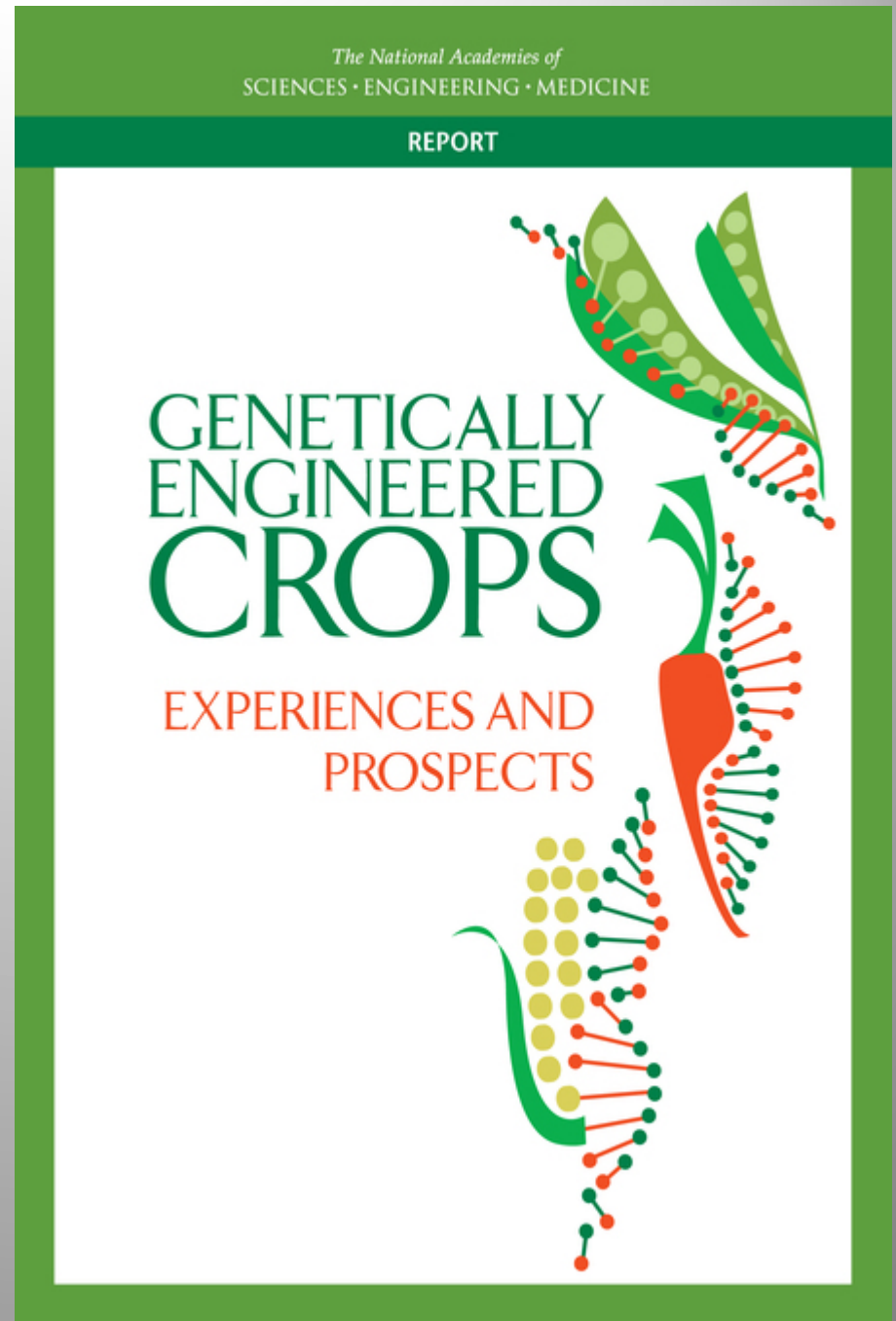
# There are numerous myths that are rampant and recycled in media



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

# National Research Council Report 2016

- Confirmed food safety
- Confirmed insecticide reduction with pest resistant corn





# Is GM food safe?

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



The American Association for the Advancement of Science (AAAS) is the premier scientific body in the United States. It is the largest non-profit organization in the world with over 100,000 members.



The American Medical Association (AMA) is the premier body of physicians in the United States. It is the largest non-profit organization in the United States.



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



The National Academy of Sciences is an independent organization in the United States that 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 has been reported.



The American Council on Science and Health (YACSH) is a non-profit organization that is the premier scientific body in the United States.

With the continuing accumulation of scientific evidence, the safety of GM foods is becoming increasingly clear. The complete absence of any evidence of human health problems associated with the ingestion of these crops has been reported.



The American Society for Microbiology (ASM) represents over 42,000 microbiologists worldwide. It is the premier scientific body in the United States.

The ASM is not aware of any credible evidence that GM crops produced with biotechnology and subjected to FDA oversight constitute a higher risk or are unsafe. We are confident that the safety of GM crops is supported by the scientific evidence.



CAST is a non-profit organization that is the premier scientific body in the United States. It is the largest non-profit organization in the United States.

Transgenic crops on the market today are safe to eat. Conventional counterclaims, and clearly more so, have been refuted by scientific scrutiny to which they are exposed.



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



The Society of Toxicology (SOT) is a professional and scholarly organization of scientists from academic institutions, government, and industry.

Scientific evidence indicates that the process of GM food production is entirely safe. The level of safety of current GM foods to consumers appears to be equivalent to that of traditional foods.



The Union of European Biologists is a professional and scholarly organization of scientists from academic institutions, government, and industry.

In a continuing effort to improve GM plant production in the US, the US has been the first to approve GM crops. The safety of GM crops is supported by the scientific evidence.

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

# Is GM food safe?

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



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

"The 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 health problems."



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 technologies."

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



# 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)

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JANUARY 28, 2015

PUBLIC AND SCIENTISTS' VIEWS ON SCIENCE AND SOCIETY

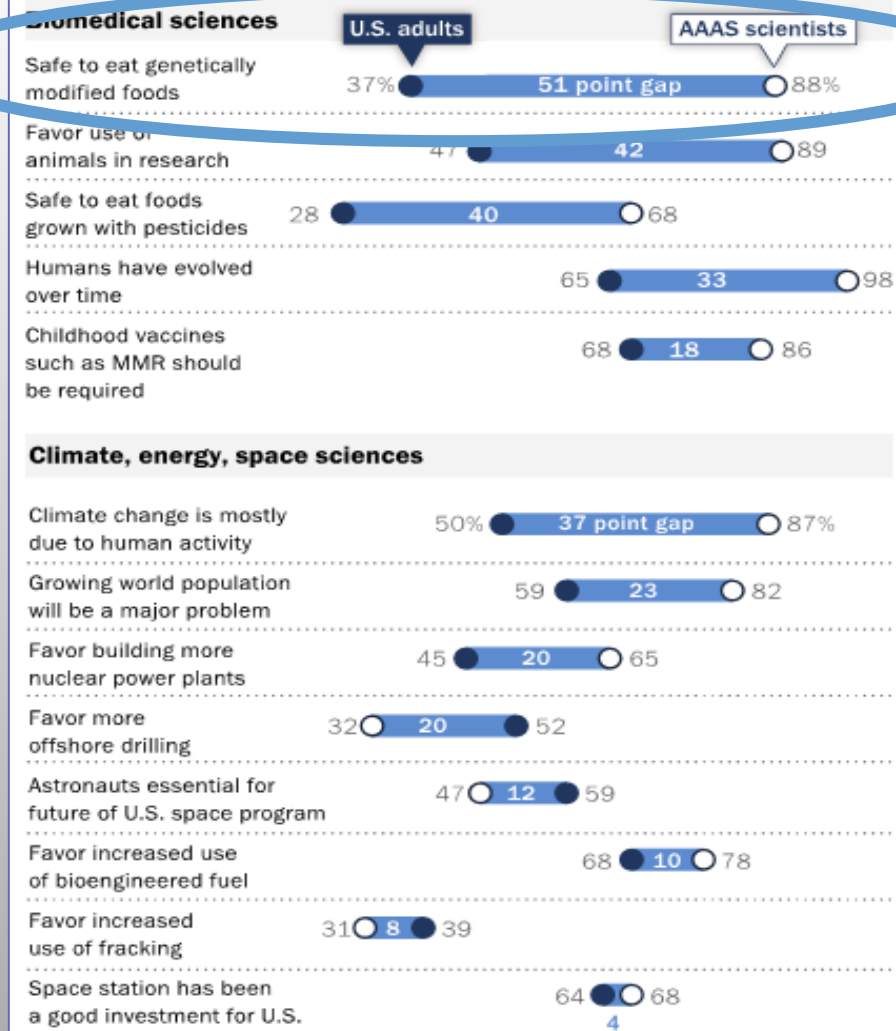
## 88% of AAAS scientists say genetically modified foods are safe to eat; only 37% of the public agrees



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

## Opinion Differences Between Public and Scientists

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



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

PEW RESEARCH CENTER

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
  
- **A general technology:** More like a wheel or computer than a medicine or saxophone
  
- **“Product not process,” “case by case,”** is global consensus for science assessments



# The more relevant questions

- Is agriculture becoming more productive, more sustainable, efficient, and resilient?
- Is food becoming safer and more nutritious?
- There are no silver bullets: making progress requires making intelligent choices, management tactics, and tradeoffs to move in the right direction ?



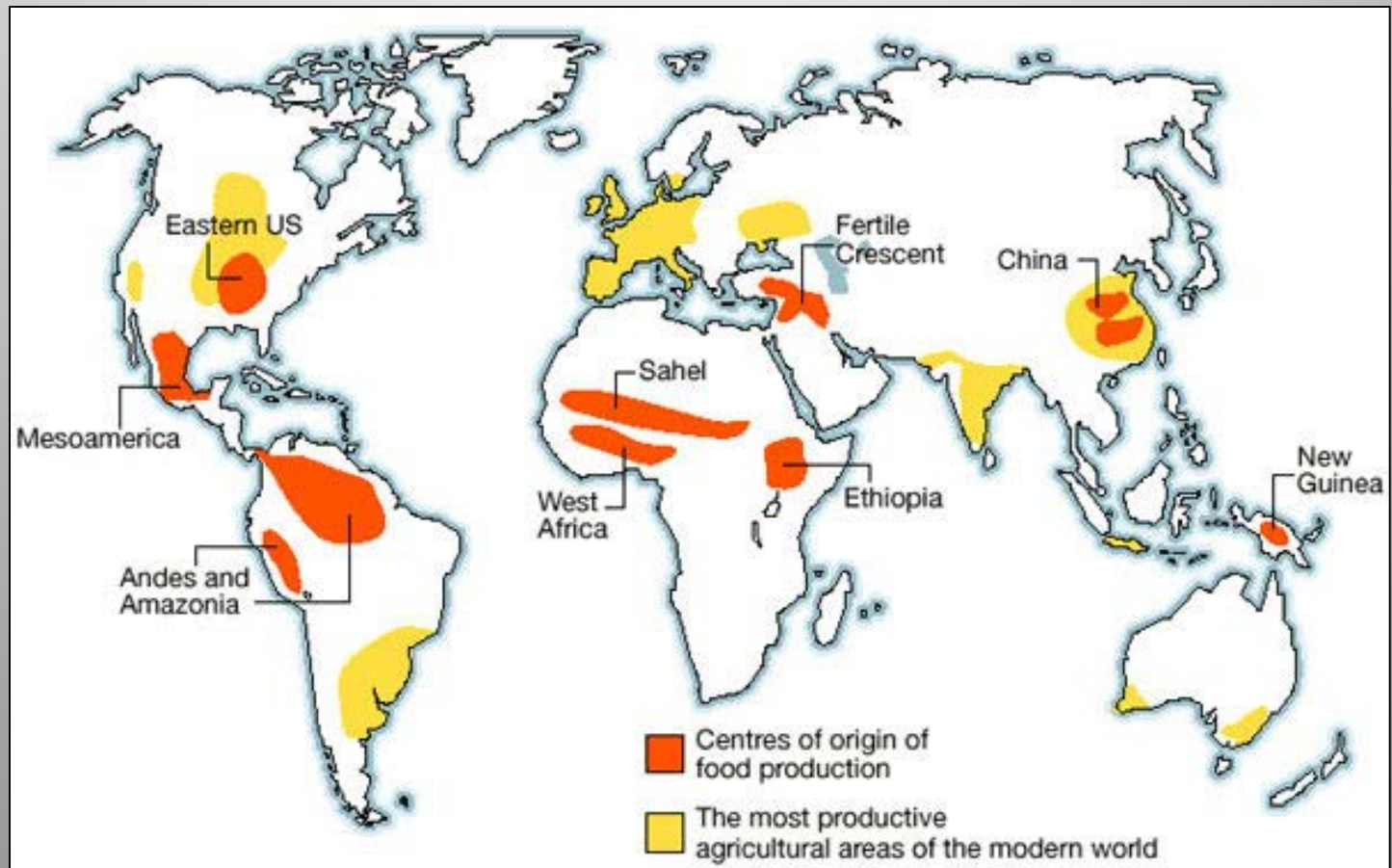


# Agenda

- What they are and are not – a brief reminder
- Extent in the world
- Some impacts
- New forms in pipeline
- Why so controversial, stigmatized?

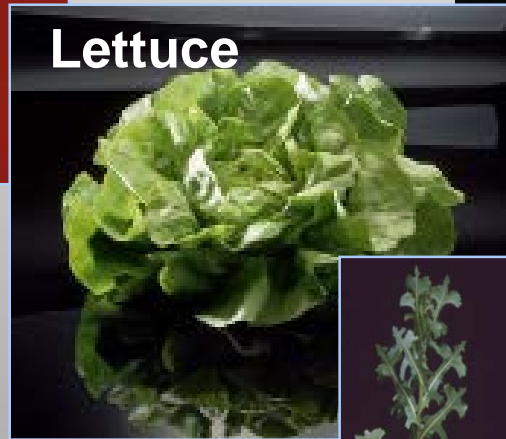
# Where did our crops come from?

Answer: All over the world



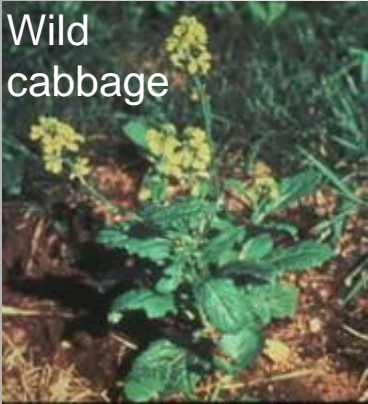
Reprinted by permission from Macmillan Publishers Ltd.: [Nature] Diamond, J. (2002). Evolution, consequences and future of plant and animal domestication. Nature 418: [700-707](#), copyright 2002.

# Most crops intensively bred, prior to GMOs





# Mutants are some of our best friends: Domestication of wild cabbage



Wild cabbage



Kohlrabi  
Germany, 100 AD

Ornamental kale  
Late 1900's



Kale, 500 BC



Cauliflower  
1400's



Broccoli  
Italy, 1500's



Cabbage, 100 AD



Brussel sprouts  
Belgium, 1700's



# Many plant varieties derived from randomly induced mutations



Calrose 76 semi-dwarf rice

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



High oleic sunflower



Rio Red grapefruit



# Radical changes in domesticated animals

All dogs derived from the wolf by breeding



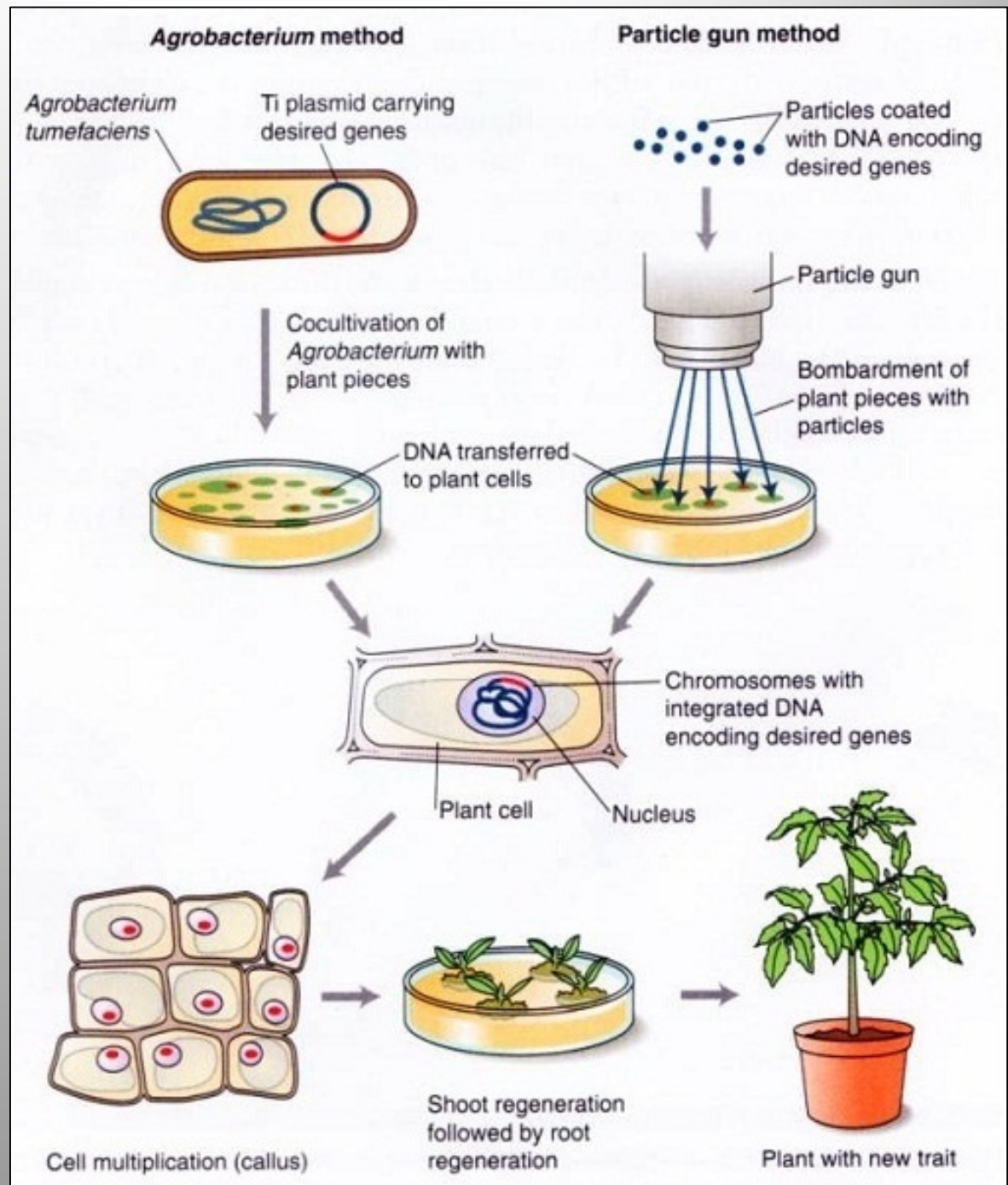
**Bottom line:** The crops we grow, and thus the food we eat, are not natural

# What is genetic engineering (GE)

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



# Steps to create a GE plant





Then plants are propagated normally (seeds, cuttings) and tested for health and new qualities



**Propagation of poplars  
in tissue culture**

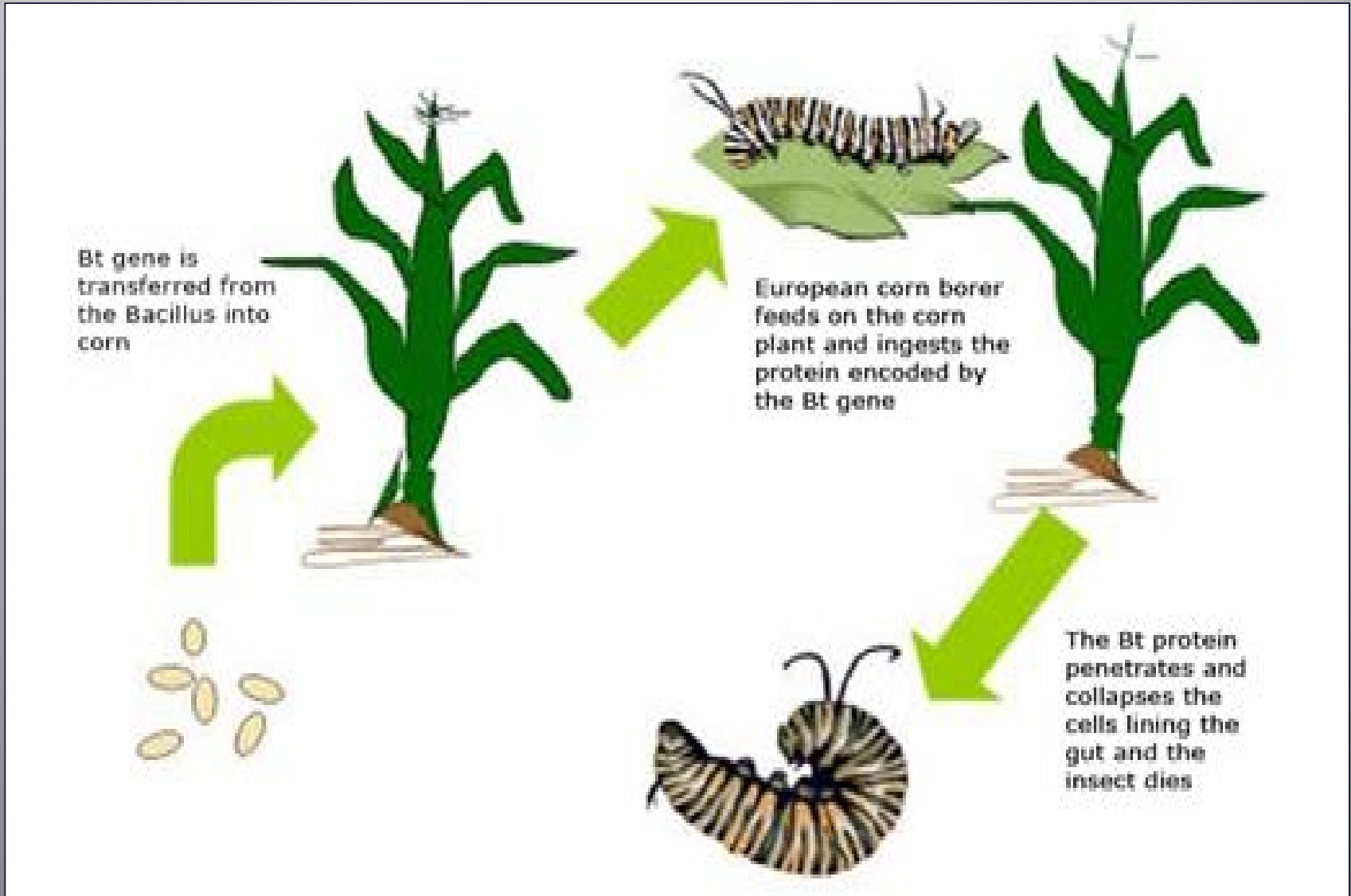


**Growth in the field**



# Insect-resistant “Bt crops”

More efficient and less harmful to non-targets than sprays --  
Bt sprays widely used in organic agriculture



Breakthrough of the Year, 2015

Science  
AAAS

2015

BRE  
of t

JULY 4, 2015

TIME

# The Gene Machine

What the CRISPR experiments mean for humanity *By Alice Park*

time.com

# Sandman CRISPR !



# Markets are another thing....

The National Organic Standard Boards has **banned** gene editing technologies

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## Organic board bans gene editing technology

[CATTLE AND BEEF INDUSTRY NEWS](#)

NOV 25, 2016 By [KERRY HALLADAY, WLJ MANAGING EDITOR](#)



When a government agency describes something as causing the “demise” of species and displacing Americans, they must surely be describing a foreign enemy, right? Or maybe some pandemic plaguing the countryside?

Apparently not. To the pleasure of the National Organic Standards Board, the board would, among other things, prevent the use of genetic engineering—an “excluded method” additionally attributed to the board.

“Every organic stakeholder has a right to organic integrity. Every effort must be made to protect that integrity,”

Among other things, the board has banned the use of Cas 9, Zinc Finger Nucleases, and other genetic engineering for the purpose of “excluded methods” of production.

“Every organic stakeholder is clear that genetic engineering is an imminent threat to organic integrity. Every effort must be made to protect that integrity,”



# Agenda

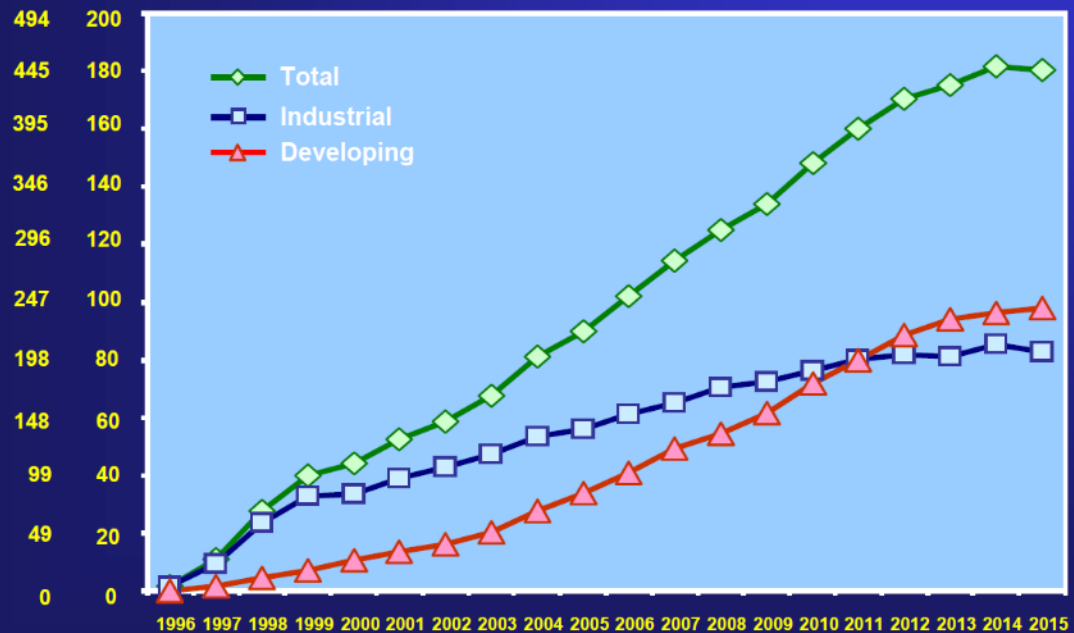
- What they are and are not – a brief reminder
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First generation herbicide and insect resistant crops were rapidly adopted by farmers, both in the developed and developing world

**Global Area of Biotech Crops, 1996 to 2015:  
Industrial and Developing Countries (M Has, M Acres)**



M Acres



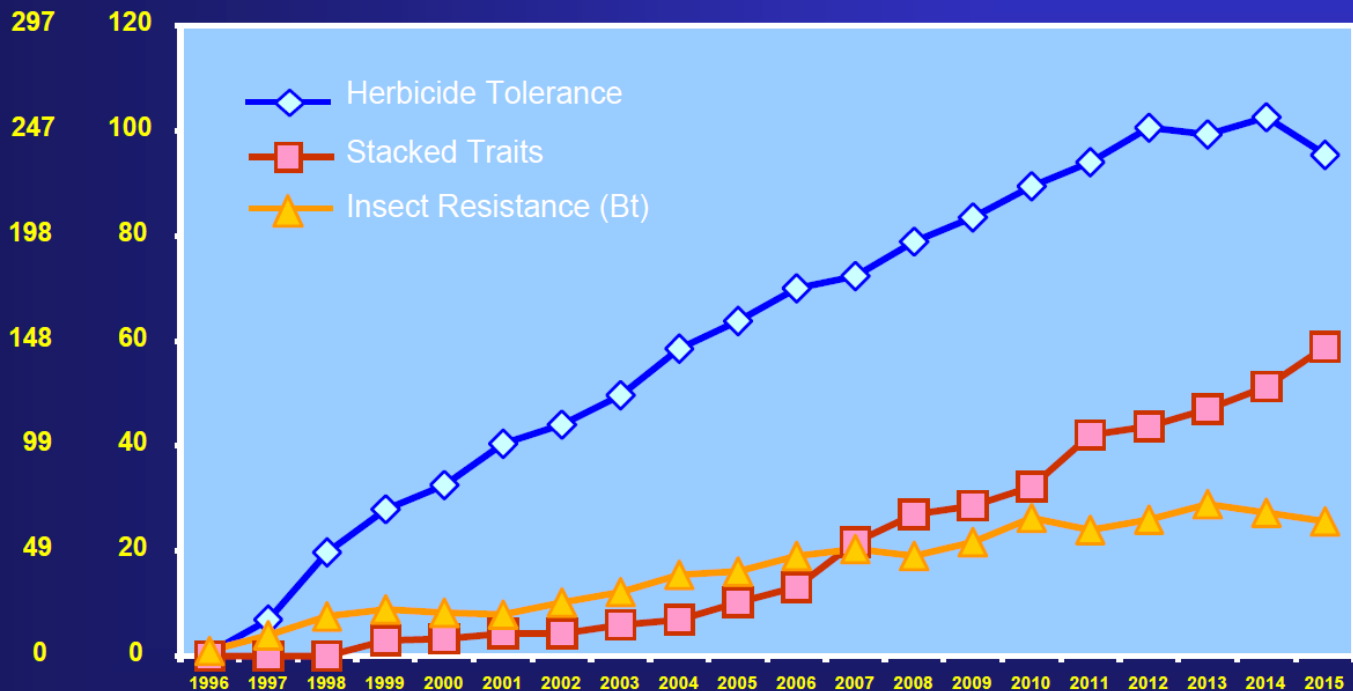
Source: Clive James, 2015

# Two traits dominate worldwide, increasingly “stacked” in combinations

## Global Area of Biotech Crops, 1996 to 2015: By Trait (Million Hectares, Million Acres)



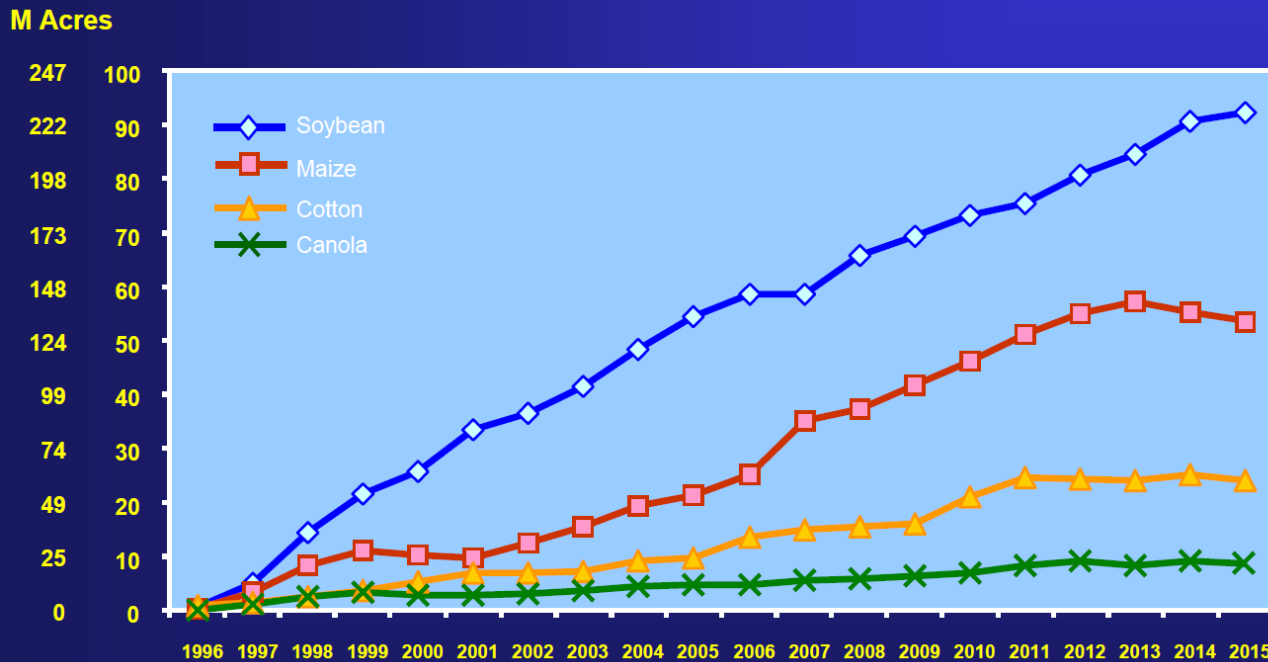
M Acres



Source: Clive James, 2015

# Four crops dominate, 8+ crops in USA

**Global Area of Biotech Crops, 1996 to 2015:  
By Crop (Million Hectares, Million Acres)**



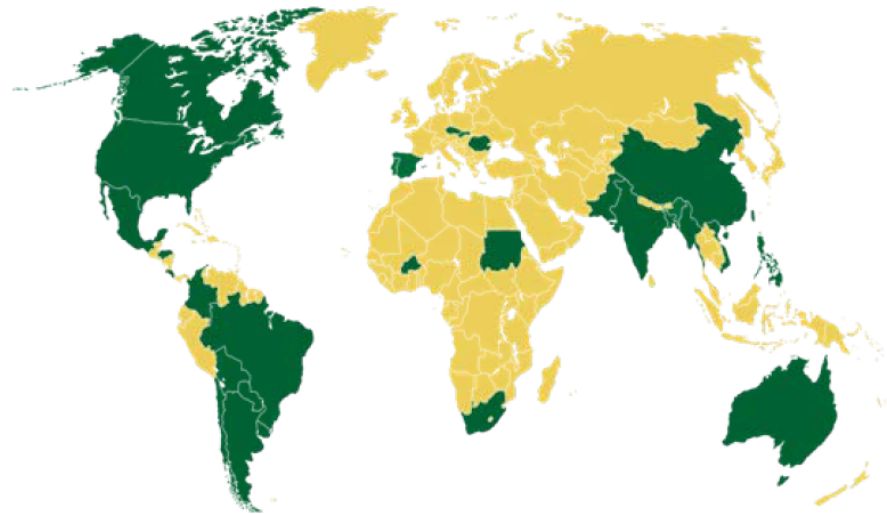
Source: Clive James, 2015



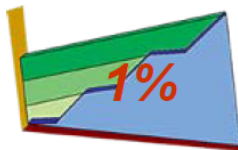


# Adoption by 28 countries, but rates highly variable

## Global Area (Million Hectares) of Biotech Crops, 2015: by Country



Marginal Decrease from 2014



28 countries which have adopted biotech crops

In 2015, global area of biotech crops was 179.7 million hectares, representing a marginal decrease of 1% from 2014, equivalent to 1.8 million hectares.

Source: Clive James, 2015.

### Biotech Mega Countries

50,000 hectares (125,000 acres), or more

Million Hectares

1.	USA	70.9
2.	Brazil*	44.2
3.	Argentina*	24.5
4.	India*	11.6
5.	Canada	11.0
6.	China*	3.7
7.	Paraguay*	3.6
8.	Pakistan*	2.9
9.	South Africa*	2.3
10.	Uruguay*	1.4
11.	Bolivia*	1.1
12.	Philippines*	0.7
13.	Australia	0.7
14.	Burkina Faso*	0.4
15.	Myanmar*	0.3
16.	Mexico*	0.1
17.	Spain	0.1
18.	Colombia*	0.1
19.	Sudan*	0.1

Less than 50,000 hectares

Honduras*	Slovakia
Chile*	Costa Rica*
Portugal	Bangladesh*
Vietnam*	Romania
Czech Republic	

\* Developing countries

# Accidental mixing of GM and non-GM crops/food create great problems

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

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

Source: UN Photo/Tobin Jones



Source: UN Photo/Tobin Jones

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

18 Likes

# Local controversy too: GMO ban voted on in Benton County, Oregon in 2015

Statesman Journal  
A GANNETT COMPANY

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## Voters reject proposal to ban GMO food in County

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



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

Top Quality  
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S



# Agenda

- What are they and are not – a brief reminder
- Extent in the world
- Some impacts
- New forms in pipeline
- Why so controversial, stigmatized?

# 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



Courtesy of Denis Gonsalves, formerly  
of Cornell University

GMO, virus-  
resistant trees

# Global “meta-analysis” of early impacts: 2014



The screenshot shows the PLOS ONE website interface. At the top left is the PLOS ONE logo. Navigation links for 'Subject Areas', 'For Authors', and 'About Us' are visible. A search bar is located at the top right. Below the navigation is a white banner with 'OPEN ACCESS' and 'PEER-REVIEWED' icons. The article title 'A Meta-Analysis of the Impacts of Genetically Modified Crops' is prominently displayed, along with the authors 'Wilhelm Klümper, Matin Qaim' and the publication date 'November 3, 2014'. A statistics box on the right shows 2 Saves, 0 Citations, 79,064 Views, and 948 Shares.

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RESEARCH ARTICLE

## A Meta-Analysis of the Impacts of Genetically Modified Crops

Wilhelm Klümper, Matin Qaim 

Published: November 3, 2014 • DOI: 10.1371/journal.pone.0111629

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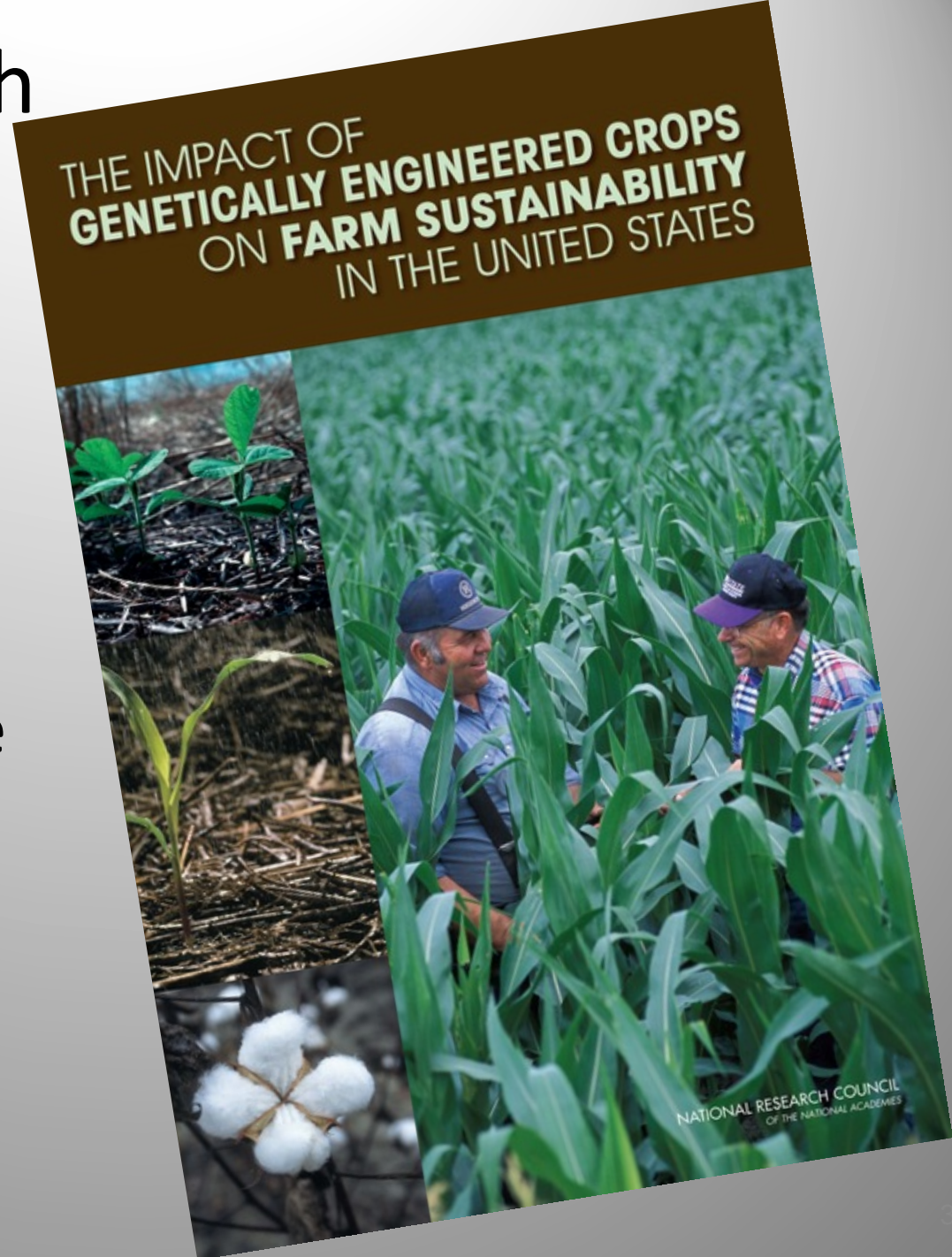
“147 original studies were included.”

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



# National Research Council Report 2010

- Major pesticide reductions - Bt
- Expanded conservation tillage
- Herbicide tolerant weeds
  - Need more sustainable management



# 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





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

And motivated development of new kinds of herbicide tolerant crops

nature  
biotechnology

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

NATURE BIOTECHNOLOGY | NEWS

## Glyphosate resistance threatens Roundup hegemony

Emily Waltz

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

PDF Citation Reprints Rights & permissions Article metrics

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



\*The number of weed species evolving resistance to glyphosate

BILL BARNESDALE / AGSTOCKUSA /





# Roundup tolerant bentgrass escape in Oregon

## 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.

483

## GMO grass divides gra



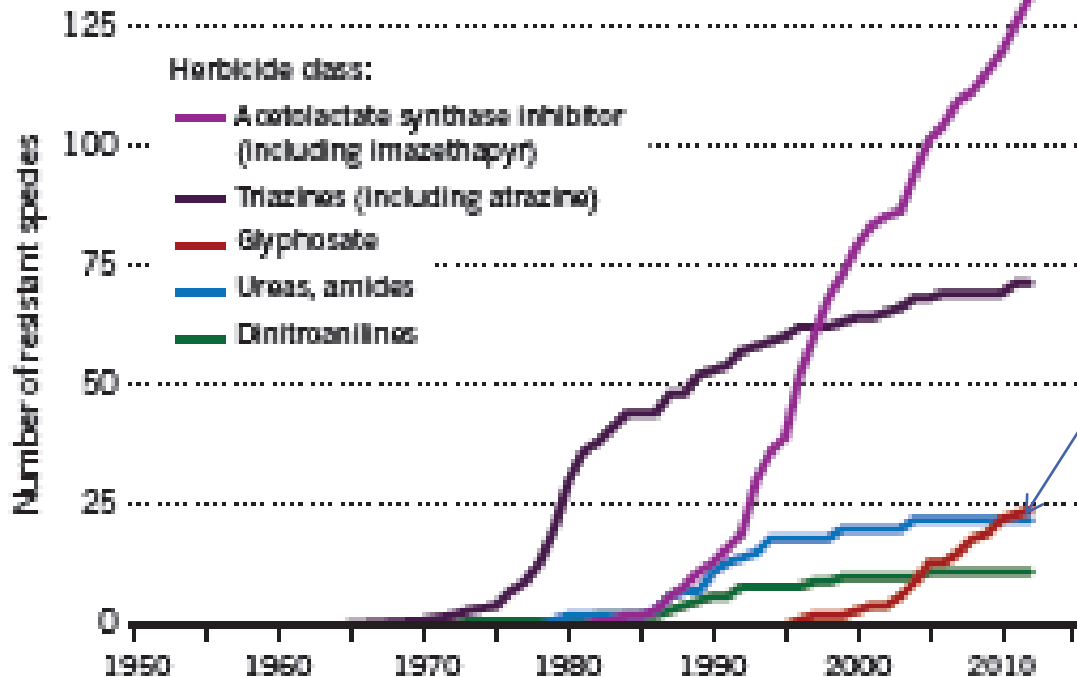
8.1k shares

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

## THE RISE OF SUPERWEEDS

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

SOURCE: UNIVERSITY OF CALIFORNIA, SURVEY OF HERBICIDE RESISTANT WEEDS WWW.WR.EDUC.UMD.EDU/RESOURCES/RESISTANTWEEDS (2010).



Accelerated by  
GE Roundup-  
tolerant crops ?



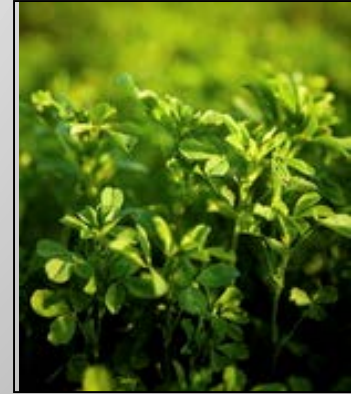
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- Some impacts
- **New forms in pipeline**
- Why so controversial, stigmatized?



# Newly approved GE crop varieties in USA

- Soybean – insect resistant (Apr. 2014)
- Alfalfa – reduced lignin (Nov. 2014)
- Potato – reduced black spot bruise and low acrylamide production (Nov. 2014), reduced browning and disease resistant as well (August 2015)
- Soybean and cotton – new herbicide tolerances (Jul. 2014 – Jan. 2015)
- Apple – non-browning (Feb. 2015)
- Plum – virus resistant (2014)

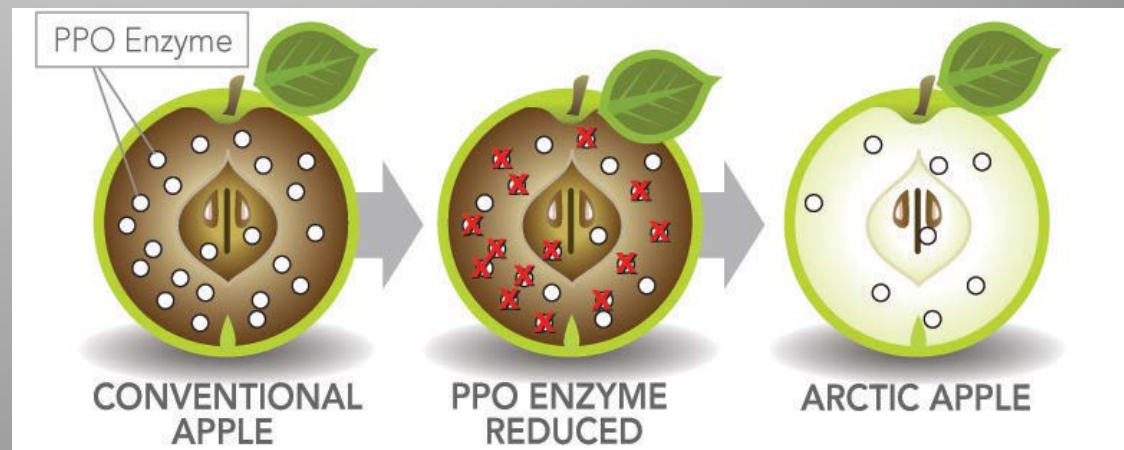


# Non-browning “Arctic Apple”

Reduced spoilage/waste, improved quality – USDA approved



Courtesy of Jennifer Armen,  
Okanagan Specialty Fruits,  
Canada



# Non-browning “Arctic Apple”

Time lapse video







### Arctic Apples

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

They tasted good for  
several hours



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

One hour after cutting – Control vs. Innate

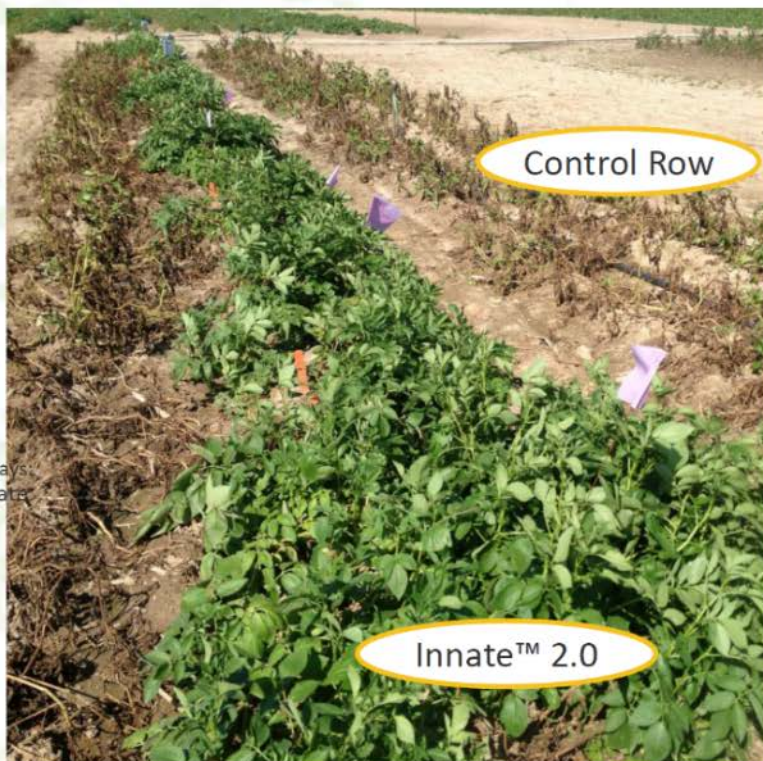


Two days after cutting –  
Control vs. Innate



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

Midwest - Sept 4<sup>th</sup> 2013



Days  
Rate

Zebra Chip

Control

Innate™ 2.0



Burbank



Innate™  
Burbank





# Potential Innate Potato benefits

- If all USA potatoes had it's improved traits, each year....
- Waste reduced by 5 billion pounds
- CO<sub>2</sub> emissions reduced by 734 million pounds
- Water use reduced by 84 billion gallons
- 2.5 million fewer pesticide acre-applications
- Marketable yields increase ~ 20%
- Growers save \$240 million in production costs







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



Food for Thought A lecture series on the science of food and food technology

# GOLDEN RICE

Humanitarian Vision and Political Roadblocks

## Ingo Potrykus

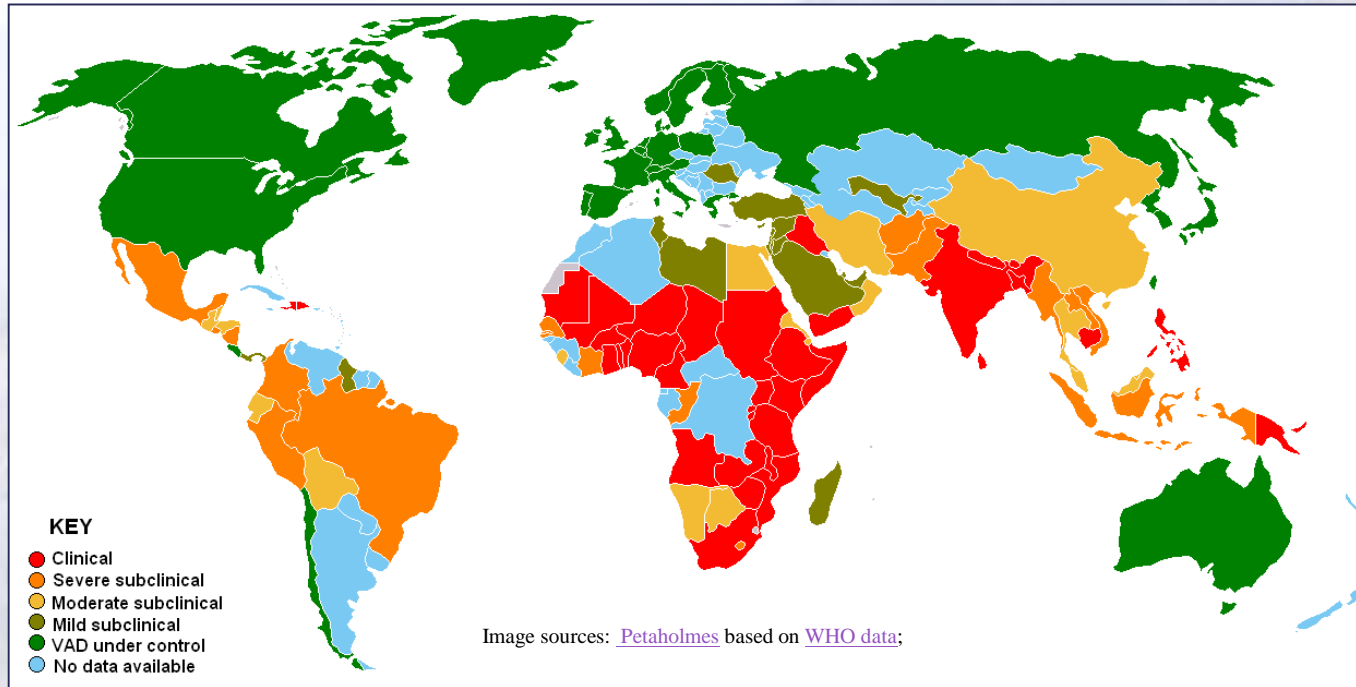
Science Community Lecture  
Genetic Engineering of Pro-vitamin A Production in Rice  
THURSDAY OCT. 13 4-5PM  
Agriculture and Life Sciences Building (AC-1) Rm. 4001

\*Genetically engineered with pro-vitamin A may be capable of helping millions of impoverished children in the developing world. Dr. Ingo Potrykus shares the basic science of how it was created, how it has been received in Europe and the developing world, and the personal and political battles he has faced during its development.

The poster features a bowl of golden rice on a blue bowl with a world map. The text includes the title "GOLDEN RICE", a subtitle "Humanitarian Vision and Political Roadblocks", the speaker's name "Ingo Potrykus", and details for a "Science Community Lecture" on Thursday, Oct. 13, 4-5 PM in Agriculture and Life Sciences Building (AC-1) Rm. 4001. A quote at the bottom describes the potential of the rice to help children in the developing world.

# Why use breeding and biotechnology for $\beta$ -carotene (pro-vitamin A) enrichment?

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



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....



# Biofortified plants are improving nutrition for many today, and can do more with aid of GE methods



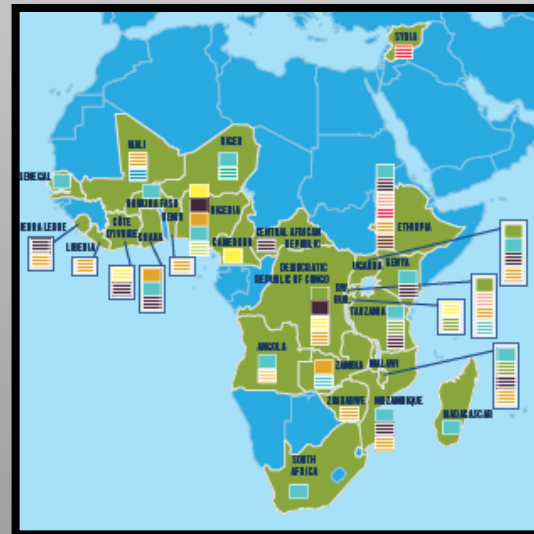
**Biofortification breeding well underway**, including a provitamin A enriched sweet potato that is **currently** being grown by > half a million families.

Other projects are underway to increase levels of protein, iron, zinc, antioxidants, and other beneficial components in food.

Gates Foundation a major supporter

# The HarvestPlus program – worldwide impact by traditional breeding

- Nutrient targets start at:
  - 30% of the EAR of iron
  - 40% of the EAR of zinc
  - 50% of the EAR of provitamin A
- Reaches more than 40 countries



# Biotech methods useful where breeding is ineffective or slow

- Rice
- Cassava
- Sorghum
- Banana

Rice



Cassava



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- Some impacts
- New forms in pipeline
- Why so controversial, stigmatized?



# Why the GMO controversy ?

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

**CAST**  
COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY

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**ISSUE PAPER**  
NUMBER 29      FEBRUARY 2005

**AGRICULTURAL ETHICS**

**I**NTRODUCTION  
It is widely known that agriculture has a long history. Starting approximately 12,000 years ago, the domestication of plants and animals began independently in several different places, including centers in West Asia, East Asia, Central America, and South America. Domestication also may have occurred in other locations, although convincing archeological evidence has not been found. In the

**TASK FORCE MEMBERS:** Jeffrey Burkhardt, Chair, Department of Food and Resource Economics, University of Florida, Gainesville; Gary Comstock, Department of Philosophy and Religion, North Carolina State University, Raleigh; Peter G. Hartel, Department of Crop and Soil Sciences, University of Georgia, Athens; Paul B. Thompson, Department of Philosophy, Michigan State University, East Lansing; **REVIEWERS:** Maarten J. Chrispeels, Center for Molecular Agriculture, University of California–San Diego; Charles C. Muscoplat, College of Agricultural, Food and Environmental Sciences, University of Minnesota, St. Paul; Robert Streiffer, Department

commented on the importance of agricultural knowledge in the quest for the “good life” by the individual and the polity. The fundamental value of agriculture was highlighted by Enlightenment thinkers from John Locke to Thomas Jefferson, who underscored the political, economic, and philosophical importance of “tillers of the soil” (Spiegel 1991). In the United States, problems faced by farmers became the focus of the nine-

# What are the key factors?

1. Complexity in an internet powered world looking for slogans and simple answers
  - Clean label movement
2. Vested interest in stigma for economic and ideological reasons
  - GMO-free food popular, creating mixture problems
  - Internet, media celebrity experts
  - Fake and “half-truthed” news and science
3. Phobia for pesticides, chemicals in any dose
  - The “Food Babe” effect
4. Scientific novelty and complexity vs. inertia of regulations and marketing systems

# My list of key factors

5. Roles and perceptions of large seed/chemical and food corporations – the “Monsanto effect”
6. Tool in global battles / trade wars
7. Scientific complexity of environmental impacts – biodiversity vs. climate vs. pesticide impacts
8. Poor management, fear of herbicide tolerant GE crops
9. Legal complications and perceptions around gene flow and patents
10. Decreasing confidence in experts, scientists – who to trust?



# More fun....

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

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



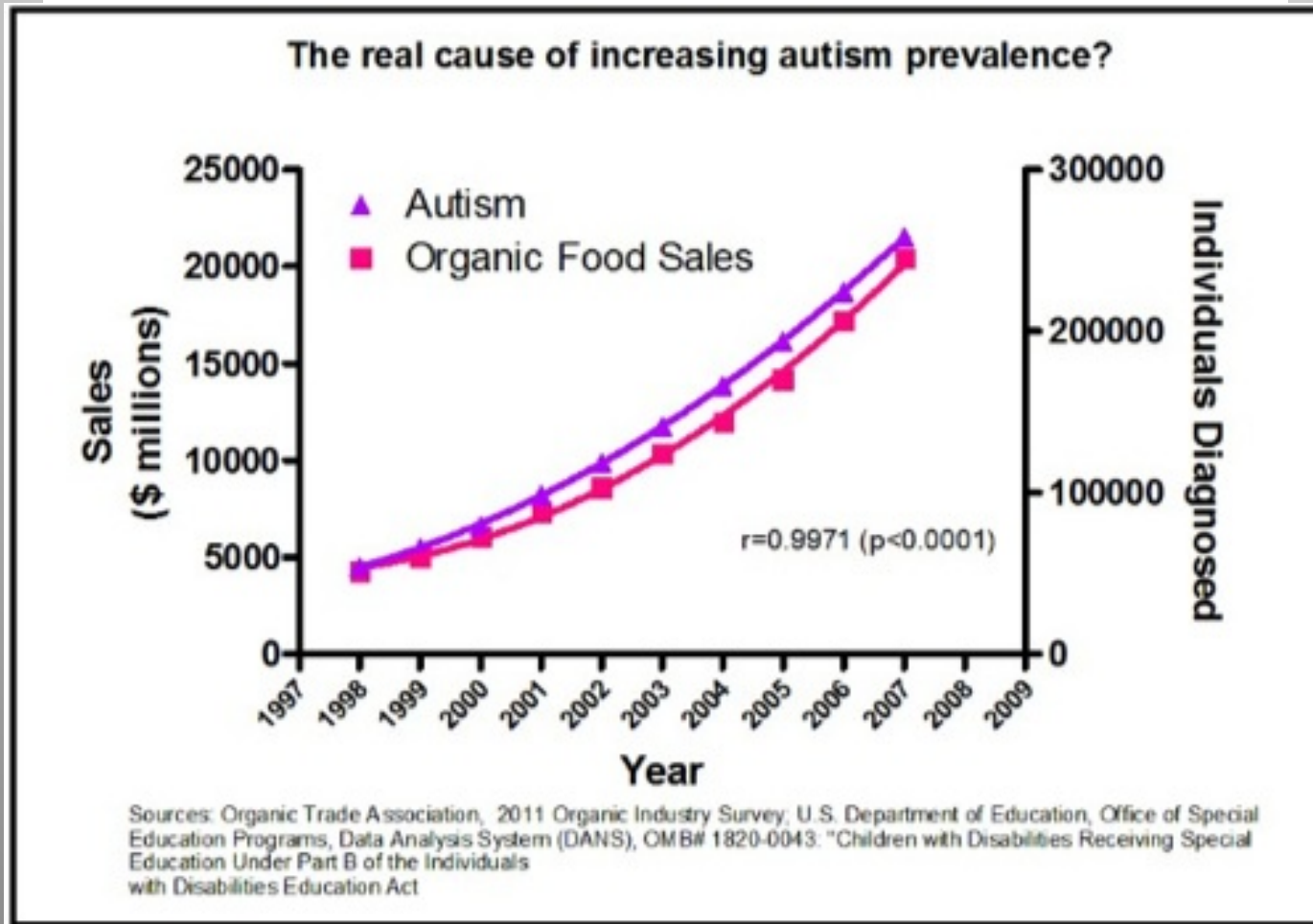
## TAKE A BITE



My colleague  
Steve Savage's  
favorite!

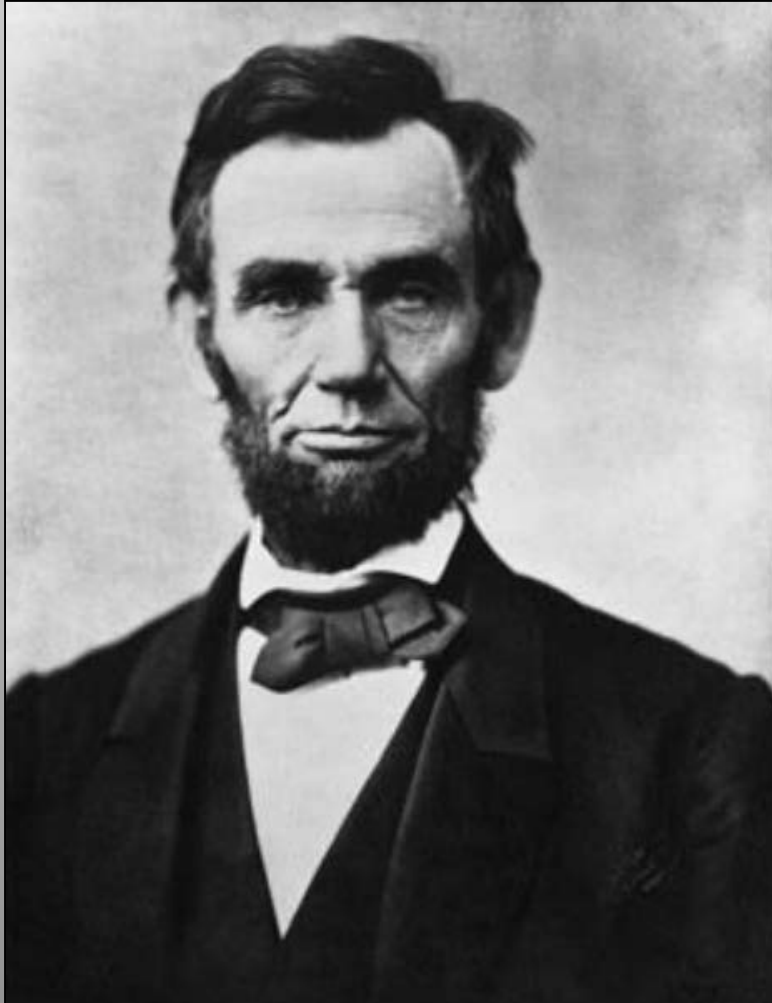


Much pseudo-science: “Half of all children will be Autistic by 2025 due to Roundup warns MIT scientist”





# Abe Lincoln warned us, but....



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

**—Abraham Lincoln**

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



# Trend of the Year: Clean Label

Industry answers the call for simple ingredients



Kraft has announced that the orange glow of its iconic Macaroni & Cheese will no longer come from synthetic coloring agents. (Kevin Diasezian / Getty Images)

ment for

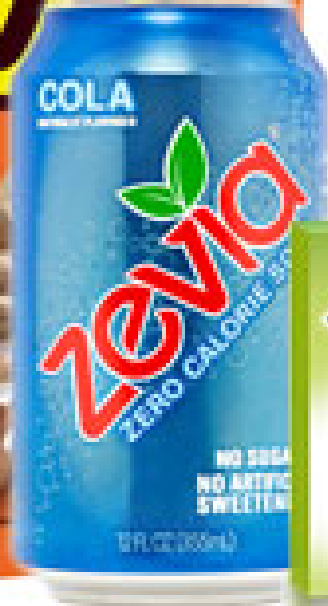


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<http://features.foodbusinessnews.net/corporateprofiles/2015/trend-index.html>

<http://www.chicagotribune.com/business/sc-clean-labels-food-0210-20160218-story.html>



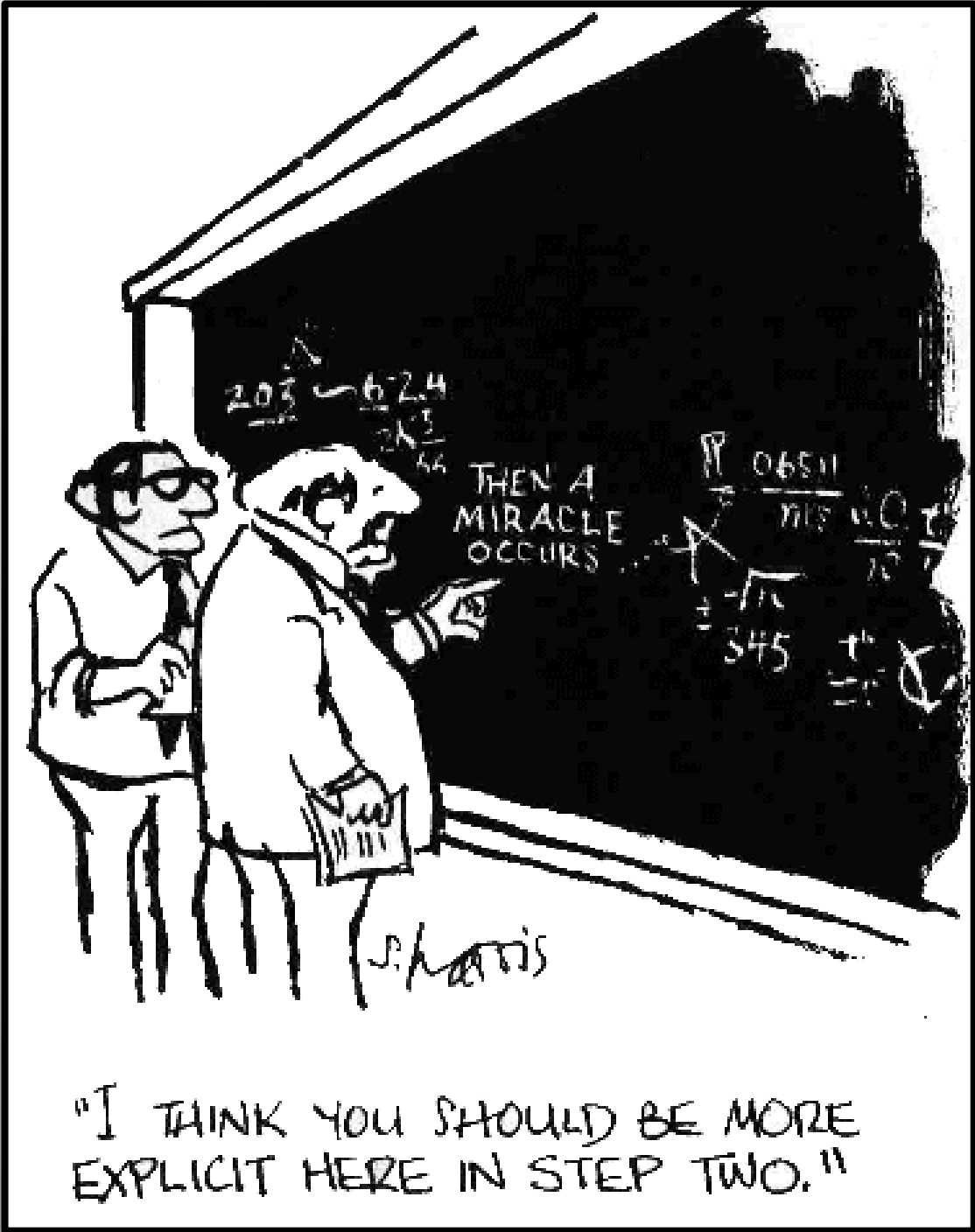


# GMO-free labels a significant feature of clean label movement



# Summary

- GMO is a breeding method not a particular kind of product
- Large benefits for economics, soil tillage, humanitarian applications
- Also very significant management, global acceptance, and trade problems
- Diverse pipeline of new products
- “Clean label” movement limiting GMOs, teaching public they are unsafe as a group?
- Decreasing trust in scientists, government, media, many institutions inflames and confuses



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