GMO Crops
What are they, where are they, and why all the fuss?

Steve Strauss
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Speaking today as a citizen, not as an OSU professor

Nothing I say is meant to present a policy or action taken by OSU
Speaking as scientist, and seeking to reflect what mainstream science is thinking and saying.
Scientists and society can differ greatly

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.
### Opinion Differences Between Public and Scientists

<table>
<thead>
<tr>
<th>Opinion</th>
<th>U.S. adults</th>
<th>AAAS scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biomedical sciences</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe to eat genetically modified foods</td>
<td>37%</td>
<td>88%</td>
</tr>
<tr>
<td>Favor use of animals in research</td>
<td>47%</td>
<td>89%</td>
</tr>
<tr>
<td>Safe to eat foods grown with pesticides</td>
<td>28%</td>
<td>68%</td>
</tr>
<tr>
<td>Humans have evolved over time</td>
<td>65%</td>
<td>98%</td>
</tr>
<tr>
<td>Childhood vaccines such as MMR should be required</td>
<td>68%</td>
<td>86%</td>
</tr>
<tr>
<td><strong>Climate, energy, space sciences</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate change is mostly due to human activity</td>
<td>50%</td>
<td>87%</td>
</tr>
<tr>
<td>Growing world population will be a major problem</td>
<td>59%</td>
<td>82%</td>
</tr>
<tr>
<td>Favor building more nuclear power plants</td>
<td>45%</td>
<td>65%</td>
</tr>
<tr>
<td>Favor more offshore drilling</td>
<td>32%</td>
<td>62%</td>
</tr>
<tr>
<td>Asteroids essential for future of U.S. space program</td>
<td>47%</td>
<td>59%</td>
</tr>
<tr>
<td>Favor increased use of bioengineered fuels</td>
<td>68%</td>
<td>74%</td>
</tr>
<tr>
<td>Favor increased use of fracking</td>
<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>Space station has been a good investment for U.S.</td>
<td>64%</td>
<td>68%</td>
</tr>
</tbody>
</table>

Mainstream science is supportive of responsible uses of GMOs

REVISED POSITION STATEMENT ON PLANT GENETIC ENGINEERING

Advances in agriculture are cumulative and build on the integration of new approaches with established breeding techniques and farming practices. The Food and Agricultural Organization anticipates the need for a 70% increase in agricultural productivity to meet the food, feed, fiber and fuel needs of an ever-growing world population, without further degrading the environment.

The American Society of Plant Biologists (ASPB) supports the continued responsible use of genetic engineering (hereafter referred to as GE) as an effective tool for advancing food security and reducing the negative environmental impacts of agriculture. ASPB also supports the continued use and further development of appropriate, science-based procedures and regulations and reducing the negative environmental impacts of agriculture. ASPB also supports the

The use of GE to modify plants represents an important advance in plant science and agriculture that builds on centuries of human involvement in the genetic modification of crop species. GE allows for the transfer into a plant of well-characterized genes. The precision of this technology, coupled with the knowledge of the specific nature of the manipulated genetic information, makes the risks of unintended consequences of this type of gene transfer comparable to or less than the random mixing of genes that occurs during classical breeding (National Research Council, 2004).
“Legally mandating such a label can only serve to mislead and falsely alarm consumers”
http://www.axismundionline.com/blog/the-new-is-gm-food-safe-meme/
Agenda

• What are and are not GMOs?
• What are the major GMO crops?
  • What is coming?
  • Traits/impacts
• Sources of “fuss”
  • Benton Co. ballot measure
These are highly genetically modified but not GMO
Many crucifer crops derived from wild cabbage – not GMO

Wild cabbage

Kohlrabi
Germany, 100 AD

Ornamental kale
Late 1900's

Kale, 500 BC

Cauliflower
1400's

Brussel sprouts
Belgium, 1700's

Cabbage, 100 AD

Broccoli
Italy, 1500's
Many plant varieties derived from induced mutations – not GMO

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.
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.

<table>
<thead>
<tr>
<th>Description</th>
<th>Not Likely</th>
<th>Likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food product made with oils modified by biotechnology to provide more healthful fats, like Omega-3, in the food</td>
<td>28%</td>
<td>72%</td>
</tr>
<tr>
<td>Variety of produce modified by biotechnology to reduce the potential for carcinogens (n=501)</td>
<td>31%</td>
<td>69%</td>
</tr>
<tr>
<td>Variety of produce modified by biotechnology to be protected from insect damage and required fewer pesticide applications</td>
<td>31%</td>
<td>69%</td>
</tr>
<tr>
<td>Bread, crackers, cookies, cereals, or pasta made with flour modified to use less land, water, and/or pesticides</td>
<td>31%</td>
<td>69%</td>
</tr>
<tr>
<td>Bread, crackers, cookies, cereals, or pasta made with flour modified to enhance nutritional benefits</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>Food product made with oils modified by biotechnology to eliminate the trans fat content in the food*</td>
<td>33%</td>
<td>67%</td>
</tr>
<tr>
<td>Variety of produce modified by biotechnology to improve vitamin content (n=499)</td>
<td>35%</td>
<td>65%</td>
</tr>
<tr>
<td>Variety of produce modified by biotechnology to taste better or fresher</td>
<td>42%</td>
<td>58%</td>
</tr>
</tbody>
</table>

*Note: Wording change from 2012 - "reduce the saturated fat content"
A/B indicate statistical significance between years
P85, Q25 Q22 Q23. All other things being equal, how likely would you be to buy...
GMO method (genetic engineering) defined

Traditional plant breeding

Variety A

Genetic engineering

Variety B

Asexual modification or insertion from any gene source
The acronyms

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

GM, GMO = genetically modified organism
GE, GEO = genetically engineered organism

The terms “biotechnology” or “modern biotechnology” often equated with GE or GM methods
Regeneration of biotech plants
Then propagated normally (seeds, cuttings) and tested for health and new qualities, incorporated into breeding programs.
Biotech crops widespread, rapidly adopted. Grown on >10% arable land on planet, extensive uptake in developing world.

Four crops dominate, 8 crops grown in USA

Global Area of Biotech Crops, 1996 to 2013: By Crop (Million Hectares, Million Acres)

- Soybean
- Maize
- Cotton
- Canola

Two traits dominate

Global Area of Biotech Crops, 1996 to 2013: By Trait (Million Hectares, Million Acres)

Major reports on biotech crops show very large and positive impacts on economics, sustainability, in USA.
2014 global “meta-analysis”

“A Meta-Analysis of the Impacts of Genetically Modified Crops
Wilhelm Klümper, Matin Qaim
Published: November 3, 2014 • DOI: 10.1371/journal.pone.0111629

“147 original studies were included.”

“On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.”
Herbicide tolerant plants promote conservation tillage – With many environmental benefits thereof

Conservation Technology Information Center

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

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

Percent of acres

- Yellow: Conventional tillage practices
- Blue: Other conservation tillage practices (excludes no-till)
- Dark blue: No-till

HT
Conventional varieties

Conservation tillage includes no-till, ridge-till and mulch-till.
Virus-resistant GM papaya
Saved the Hawaiian industry in the mid-1990s, ~70% 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
Drought-tolerant maize – Planted on >150,000 acres – Also tested in Africa

Important tool given climate change, water shortages?
Many more stress tolerance innovations in the pipeline

NEWS FEATURE

Beating the heat

Despite the complexity of drought tolerance, researchers are making progress in the search for crops that can produce seed with limited water. Emily Waltz reports.

A revolution is quietly underway in the mid-West and Great Plains of the US. Following water shortages that have ravaged corn yields, the first of a new generation of drought-tolerant crops are being put to the test in the field.

March, Johnston, Iowa-based DuPont Pioneer announced that its newly developed transgenic corn, which downregulates production of the phytohormone ethylene, enhances grain yield after exposure to drought stress. It could join DroughtGard maize, a variety expressing a Bacillus subtilis cold-shock protein made by Monsanto of St. Louis, that has already been planted on more than 200,000 ha by thousands of farmers.

With registrations elsewhere in the world—last year, Indonesia approved a sugarcane expressing choline dehydrogenase with enhanced resistance to water deprivation—and a half-dozen other transgenic approaches to drought tolerance and water use efficiency (WUE) in testing (Table 1), biotech is making strides in bolstering crop resistance to drought. But it may not be happening fast enough. Global population increases are putting interest in drought tolerance as a trait has been on the rise over the past decade, both in industry and academia. At least 117 field trials for drought tolerance were given the green light in 2013 by US regulatory authorities alone, up from just 29 in 2004, according to data from Information Systems for Biotechnology (ISB) in Blacksburg, Virginia, a group that tracks regulatory activity. And these numbers may not include trials of drought-tolerant plants that are categorized under a more general description or an undiscovered phenotype.

Monsanto is currently conducting far more field trials of drought-tolerant crops than anyone else in the US, according to data from ISB.

Table 1: Transgenic drought tolerant crops in commercial development and on the market

<table>
<thead>
<tr>
<th>Developer</th>
<th>Crop</th>
<th>Mechanism</th>
<th>Implementation location and status</th>
<th>Field trial results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monsanto</td>
<td>Corn</td>
<td>Expresses a GUS-shock protein II from B. subtilis, which stabilizes RNA</td>
<td>Commercialized in US 2012; granted commercialization in US Western Great Plains and Midwest</td>
<td>10-30% higher sugar production than conventional counterparts during drought. Genetically, 20% higher yield; reduces the number of flowers.</td>
</tr>
<tr>
<td>Performance Plants (Kington, Ontario)</td>
<td>Sorghum, corn, cotton and rice</td>
<td>Uses RNA driven by conditional promoters to suppress transcriptional activity; shoots down stomata</td>
<td>Licensed to Seeds (Manitoba, Canada, Syngenta (Switzerland), Bayer CropScience (Montréal, Germany), DuPont Pioneer, Malagio (India), Kethal (Indonesia), and DKN (Beijing)</td>
<td>Field trials in the US and China</td>
</tr>
<tr>
<td>DuPont Pioneer</td>
<td>Corn</td>
<td>Expresses an ASCG RNA construct to downregulate ABA, synthase and decrease biosynthesis of ethylene</td>
<td>Field trials in the US and China</td>
<td></td>
</tr>
<tr>
<td>Aracelis Biosciences</td>
<td>Rice and canola</td>
<td>Expresses inhibitory transcription from Agrobacterium, which catalyzes the rate-limiting step in cytokinin synthesis, accompanied by SPO1 promoter from bean</td>
<td>Two years of US field trials in rice with combined water use efficiency, irrigate use efficiency and tillage technology licensed to farmers who have put the gene into their own varieties of rice, wheat, rice, cotton, sugar beets, sugarcane and tree crops.</td>
<td></td>
</tr>
<tr>
<td>Verdecia, a joint venture of Aracelis Biosciences and Bioventures</td>
<td>Soybean</td>
<td>Overexpresses Hsp4.4, a sunflower thought to inhibit ethylene-induced senescence</td>
<td>Field trials in Argentina and the US</td>
<td></td>
</tr>
<tr>
<td>Japan International Research Center for Agricultural Sciences</td>
<td>Wheat, soybean and sugarcane</td>
<td>Expresses DREB1A transcription factor under the control of the rLD2 promoter</td>
<td>Field trials via collaborations with International Maize and Wheat Improvement, International Rice Research Institute, International Center for Tropical Agriculture, Brazil, International Center for Agricultural Research in Dry Areas (ICARDA)</td>
<td>1-9% yield advantage over comparable varieties during drought and other stress</td>
</tr>
<tr>
<td>University of Tsukuba and Japan International Research Center for Agricultural Sciences</td>
<td>Rice and peanut</td>
<td>Expresses DREB1A transcription factor under the control of the rLD2 promoter</td>
<td>Field trials via collaborations with University of Tsukuba (India), International Rice Research Institute for the Sahel and Tropics (India, Pakistan)</td>
<td>1-9% yield advantage over comparable varieties during drought and other stress</td>
</tr>
<tr>
<td>Agricultural Genetic Engineering Research Institute (ElGiza, Egypt)</td>
<td>Wheat</td>
<td>Overexpresses H2A.1 gene from barley, which confers osmorestress resistance</td>
<td>Conducting field trials and generating biosafety data required to approval in Egypt's regulatory authorities</td>
<td>Not disclosed</td>
</tr>
<tr>
<td>Indian Agricultural Research Institute (New Delhi)</td>
<td>Tomato</td>
<td>Overexpressing stress-tolerant genes under the control of the 25S RNA promoter</td>
<td>Greenhouse studies in India</td>
<td>Better survival and growth; yield data not yet available</td>
</tr>
</tbody>
</table>
Purple GM tomatoes with increased antioxidants and rot resistance
“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.”
Healthier soy oil: Omega-3 enhanced

Non-browning “Arctic Apple”
Reduced spoilage/waste, improved quality – USDA approved

Courtesy of Jennifer Armen, Okanagan Specialty Fruits, Canada
“Innate” potato approved – 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
2nd gen “Innate” potato – late blight resistant too (↓ waste, ↑ safety, ↓ pesticide, ↑ yield)
Control of coleopteran insect pests through RNA interference

James A Baum1, Thierry Bogaert2, William Clinton3, Gregory R Heck1, Pascale Feldmann2, Oliver Ilagan1, Scott Johnson1, Geert Plaatnick2, Tichafa Munyikwa1, Michael Pleau1, Ty Vaughn1 & James Robert1-3

Commercial biotechnology solutions for controlling lepidopteran and coleopteran insect pests on crops depend on the expression of Bacillus thuringiensis insecticidal proteins1,2, most of which permeabilize the membranes of gut epithelial cells of susceptible insects3. However, insect control strategies involving a different mode of action would be valuable for managing the emergence of insect resistance. Toward this end, we demonstrate that ingestion of double-stranded (ds)RNAs supplied in an artificial diet triggers RNA interference in several coleopteran species, most notably the western corn rootworm (WCR) Diabrotica virgifera virgifera LeConte. This may result in larval stunting and mortality. Transgenic corn plants engineered to express WCR dsRNAs show a significant reduction in WCR feeding damage in a growth chamber assay, suggesting that the RNAi pathway can be exploited to control insect pests via *in planta* expression of a dsRNA.

initial bioassays, dsRNAs were applied to the surface of the WCR agar diet at concentrations from 520 ng/cm² to 780 ng/cm². As we anticipated a slower response to dsRNAs than to B. thuringiensis insecticidal proteins, the WCR bioassay incubation period was extended from 5 d to 12 d. Indeed, 7 d after infestation, little if any effect was observed. However, numerous dsRNAs exhibited significant activity 12 d after infestation, resulting in both larval stunting and mortality (Supplementary Table 1 online). Subsequent feeding assays demonstrated that certain dsRNA samples, including dsRNAs targeting putative genes encoding vacuolar ATPase (V-ATPase) subunits A, D and E, as well as *γ*-tubulin, were active at applied concentrations well below 52 ng/cm². We identified additional WCR genes that caused mortality when targeted for suppression using dsRNAs in the WCR feeding assay. A two-tiered screen was implemented in which dsRNAs targeting different genes were tested at 52 and 5.2 ng/cm². Of the 290 dsRNAs tested, 125 showed significant (*P < 0.05*) larval mortality and/or stunting at 5.2 ng/cm². Of these, 67 showed significant mortality and/or stunting.

Figure 2 F1 plants expressing a V-ATPase A dsRNA are protected from WCR feeding damage. (a) Map of the expression cassette. (b) Mean root damage ratings for eight F1 populations, the parental inbred line (negative control) and the corn rootworm–protected Cry3Bb event MON863; NiS, nodal injury score (Iowa State ranking system). (c) The plant on the left is a non-transgenic control with average root damage, whereas the plant on the right shows the average root protection seen when the transgene is expressed.
Resistance transgenes promising solution/s to devastating ‘citrus greening’
Coming: Defensin-like proteins from spinach for disease resistance

Courtesy of Eric Mirkov, Texas A & M
Helping forests: American Chestnut restoration by genetic modification

The American Chestnut's Genetic Rebirth

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

Many more examples funded by Gates Foundation / other sources
Biofortified plants are improving nutrition for many, and can do much more with aid of biotechnology.

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.

Sources: HarvestPlus; CIMMYT

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
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 childbirth-related causes, many from complications that could be reduced through more vitamin A in their diet.

20 Feb 2014

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

“Super banana”

Vitamin A Super Banana in human trials

The first human trial to test the efficacy of a genetically modified (GM) nutritionally enhanced banana is starting in the US. Conceived by researchers at the Queensland University of Technology (QUT) in Brisbane, Australia, to provide a good source of beta carotene, the Super Banana has $10 million in backing from the Bill and Melinda Gates Foundation. The genetically enriched, golden-colored banana may help prevent blindness caused by vitamin A deficiency in Ugandan children whose diets are deficient in this nutrient (Nat. Biotechnol. 30, 1017–1019, 2012). But leaders of the banana project are embarking on a historically precarious path. Golden Rice, the previous GM crop developed to alleviate vitamin A deficiency in the poor, met fierce hostility and regulatory hurdles that have plagued its development for 15 years. The rice still hasn’t been commercialized in its target country, the Philippines. Whether the banana will meet a similar fate remains to be seen.

Opposition from anti-biotech activists in the media so far has been minimal, and radical activist presence in Uganda and other African countries is generally small. “I don’t have the feel-

But is it golden? Stephen Buah (left) and James Dale, from Queensland University of Technology, display the Super Banana.
Coming: Gene editing technology for diverse traits – biotech or breeding?

TALENs

CRISPRs

PLANT BIOTECHNOLOGY

Zinc fingers on target

Matthew H. Porteus

The existing methods of creating genetically modified plants are inefficient and imprecise. Zinc-finger technology offers the prospect of opening up a swifter and more exact route for crop improvement.

NATURE|Vol 459|21 May 2009
Why the fuss?

Diverse factors

- **Human need**: Population and consumption growth, food cost, widespread malnutrition, environmental damage from agriculture

- **New and rapid science** (genes and gene transfer) give many options = technology push

- **Ethics**: Breaking of traditional boundaries in moving genes press concepts of rightness

- **Risk perception high**
  - Complex and invisible science and technology, often without direct consumer benefits = high perception of risk
  - Context of breeding and extensive modification of food crops and products unknown to most
Why the fuss, continued

- **Ideology**: Strong anti-GMO business and political forces
  - Green and organic and “natural” vs. GMO
- **Strong corporate role**: Control of seeds and agriculture, patents, industrial ag, the “Monsanto effect”
  - Communitarian vs. hierarchic ideologies (Kahan, Yale)
- **Role of governments**
  - Extent of precaution? Regulation stringency?
  - Labeling? Allowances for trade?
- **Science uncertainties**
  - Environment, food safety, allergenicity
- **Chemophobia**
  - All pesticides are bad, GMOs make worse
- **Gene flow**: Ag is leaky, gene movement common
  - Coexistence challenges with low biotech tolerances
Caution on interpreting polls – many people do not understand the basics

Rutgers survey data - USA (2005) – Prof Bill Hallman, Rutgers University

http://www.foodpolicyinstitute.org/resultpub.php

• Six in ten (60%) don't realize that ordinary tomatoes contain genes
• Fewer than half (45%) understand that eating a genetically modified fruit would not cause their own genes to become modified
Early this spring, the Indian environmentalist Vandana Shiva led an unusual pilgrimage across southern Europe. Beginning in Greece, with the international Pan-Hellenic Exchange of Local Seed Varieties Festival, which celebrated the virtues of traditional agriculture, Shiva and an entourage of followers crossed the Adriatic and travelled by bus up the boot of Italy, to Florence, where she spoke at the Seed, Food and Earth Democracy Festival. After a short planning meeting in Genoa, the caravan rolled on to the South of France, ending in Le Mas d'Azil, just in time to celebrate International Days of the Seed.

Shiva's fiery opposition to globalization such as Monsanto of attempting to impose "food totalitarianism" on the world.
“Entertaining” and strikingly misleading books and “documentaries” are common.
Money: Advocacy targeting food & agriculture is large and growing

More than 500 activist organizations in North America are spending in excess of $2 billion annually engaging in food-related campaigns targeting biotech and many other elements.

Jay Byrne, 2012, V-fluence
We are programmed to adopt polarized, simplified, emotionalized, and tribalized views.

See also his TED talks.
Pervasive online filters of information entrench

https://www.ted.com/talks/eli_pariser_beware_online_filter_bubbles
The real stuff underneath the noise

Management

Ecological impacts on wild species

Agronomics – trait management

Regulation – too much vs. too little

Coexistence given diverse market streams
Are declines in monarch butterflies—associated with reduced milkweed populations—due to improved weed control from herbicide-tolerant crops?

Additional impacts on other pollinators?
Poor weed management has led to rapid development of herbicide-resistant weeds.

And development of new kinds of herbicide tolerant crops.

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 is increasing,” the report said. “By 2018, over 20% of weeds in the US will have evolved resistance to glyphosate.”
Herbicide-resistant weeds are an old problem in agriculture, but exacerbated by GE herbicide tolerant crops.
Despite an extraordinary record of safety, are some further restrictions on use of glyphosate called for?
Significance distorted by chemophobic celebrities, naturals industry
Amplified by some mainstream media, science notwithstanding.
Significance and legitimacy of finding under serious debate

Oregon with major coexistence struggles due to seed industry, much non-GMO production & many exports.

2014 Task Force
Reasons for Benton Co. ballot measure

• Anger, economic loss over genetic admixture of biotech crops into organic, non-GMO seed and production crops
  • Beets, alfalfa, corn

• Costs of having to test non-biotech products for biotech presence

• Inability to date to work out satisfactory coexistence for all using voluntary/industry programs (e.g., Willamette Seed Association)
Reasons for Benton Co. ballot measure, continued

- Anger over increasing corporate power in seed industry
- Very concerned about the health and environmental effects of GMOs and pesticides
  - Want an agricultural system without them
- A statement / movement toward ultimately challenging and changing state laws that restrict local control, do not require labels on GMOs
My concerns with ballot measure

- **Badly written:** Wide-ranging but ambiguous on major elements
  - *What it says, not what might have been intended, will be law*
  - All research, all uses, all patents?
- **No exemptions:** Research or medical applications
- **High cost to county for lawsuits, enforcement**
  - Sets up independent regulations / legal rights that are in contradiction to Oregon and federal laws
    - State law passed in 2013 that banned local agricultural laws; violates Oregon right to farm law
    - Extensive federal regulation of GMOs by EPA, FDA, USDA
    - County must manage citizen lawsuits, control program
My concerns with ballot measure

- **Harmful, uncompensated takings**
  - Will require farmers affected by the ban to rip up crops with no compensation for losses
  - May require ongoing and future research into medical treatments, environmental protections, and agricultural sustainability that uses biotech methods to be abruptly stopped

- **Does not do what it says**: Does nothing to enhance our already vibrant local food system
OSU analysis of impacts

- “OSU estimates the measure might directly impact 120 or more faculty in eight OSU colleges;
- Stop research that was valued at $18.3 million from external funding in fiscal year 2014;
- Affect the education of 300-400 students; and
- Impact 100-200 support university staff.”
Other very worrisome elements

• Makes arguments about the inherent rights of people to local and self-government that transcend state and federal law
  • Radical political and legal action: Sure to be challenged
• Establishes mechanisms for enforcement; rights of individuals, groups, or the county to sue for enforcement; and stipulates that violation of prohibitions are subject to both civil liability and criminal culpability
  • Back to the wild west? Can the county manage this?
• Outlines a “Bill of Rights” for natural communities, foods and agriculture
  • Yet agricultural systems are anything but natural—how to put into practice and enforce?
Some final perspectives
Billions are malnourished now, and it’s a very scary future
Climate change & travel creating urgent pest problems

This Killer Fungus Could Force the Whole World to Go Gluten-Free

Wheat stem rust fungus (Photo: deadb Imagebank-Zichner)

July 15, 2014  By Izabella Wentz
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A Race to Save the Orange by Altering Its DNA

CLEWISTON, Fla. — The call Ricke Kress and every other citrus grower in Florida dreaded came while he was driving.

Field trial of Xanthomonas wilt disease-resistant bananas in East Africa

To the Editor:
Banana is a major staple crop in East Africa problemed mostly by smallholders and semi-smallholders. Its resistance to Xanthomonas (=False) wilt disease (Xw), the bacteria that causes the disease, is essential for food security and economic development in the region. The disease can lead to significant yield losses, and it is a major threat to the banana industry in East Africa. To address this problem, researchers have been working on developing disease-resistant banana varieties.

The End of Orange Juice

A recent study published in the Journal of Agricultural and Food Chemistry investigated the potential of transgenic oranges (Citrus sinensis) as a source of antioxidants. The researchers engineered the oranges to overexpress a gene that encodes for a stilbene synthase (SS) enzyme, which is known to produce stilbenes, a group of compounds with antioxidant properties. The transgenic oranges exhibited increased levels of stilbenes, leading to improved antioxidant activity compared to the wild-type oranges.

ACKNOWLEDGMENTS
We thank J.T. Young for his helpful advice on the design of the study. We also thank Dr. John T. Young for providing the construct for overexpression of the SS gene in the transgenic plants.
Pesticide poisoning common in developing world – eggplant, cotton

Non-Biotech

Biotech

Natural toxins in food pose serious problems for the poor

*Child with liver cancer in Mozambique due to consumption of mycotoxins*

- Esophageal cancer
- Neural tube defects, spina bifida
- 155,000-172,000 cases per year from aflatoxin

- Bt GMO corn above
- Fungal contaminated, mycotoxin-producing corn below
Billions suffer from micronutrient deficiency
Widespread, impacts severe, and decades of supplements unable to overcome

Vitamin A deficiency affects one-third of children under the age of five around the world

Image sources: Petaholmes based on WHO data.

Young women suffering blindness due to Vit A deficiency
GMOs are powerful tools...
But not silver bullets....
And like other technologies require integrated, prudent management

In seeking new crops to sustainably feed an expanding world population, there is compelling need for a multipronged approach that includes traditional breeding, molecular breeding, and genetic modification. We need to accelerate this new green revolution in the lab, in the field, and through better communication outside the scientific community if we are to address the nearly 3 billion chronically undernourished people worldwide.
In summary

- Remarkable progress and diverse benefits from biotech crops, with much more coming
  - Strong science record of benefit, safety
- Herbicide tolerant crops also with great benefits, but need much improved regulation and management
- Extraordinary GMO-method focused regulatory and social problems
  - In stark disagreement with science
- The grand challenge before us – Prudent, ecological management and coexistence
  - County, state, national, global levels