

Rethinking the GMO debate: science and undone science

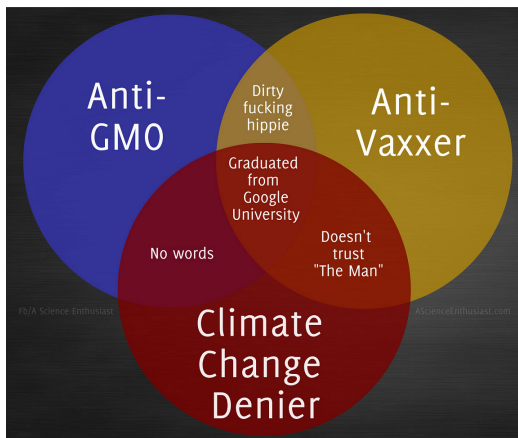
Maywa Montenegro and Alastair Iles

Department of Environmental Science, Policy & Management



Talk Overview

With so much emphasis on consumer food safety, “safety” has both occupied too much attention and been reduced to a small slice of what safety actually encompasses.



In narrowing the debate to ‘is this food dangerous to eat’, we overlook:

Ecology

biodiversity in and around agricultural landscapes

seed diversity and crop diversity

Human Health

farmer and farmworker health

nutritional quality and diversity

Knowledge & Culture

farmer autonomy and knowledge

on-farm plant breeding
heritage and foodways

Economy

ownership and access rights – who controls seed?

structure of food system

Promises and complicated realities

Russell and Hakim (2016):

“The promise of genetic modification was twofold: By making crops immune to the effects of weedkillers and inherently resistant to many pests, they would grow so robustly that they would become indispensable to feeding the world’s growing population, while also requiring fewer applications of sprayed pesticides.”

As a quick reminder: the major successes in GM technology have been two types:

- 1) **Herbicide-tolerance:** a trait confers resistance to weedkillers (most famously glyphosate, but also dicamba, 2,4-D, and others)
- 2) **Bt:** a trait that enables the crop to produce its own *Bacillus thuringiensis* pesticide, conferring resistance to insects

Case 1: Glyphosate



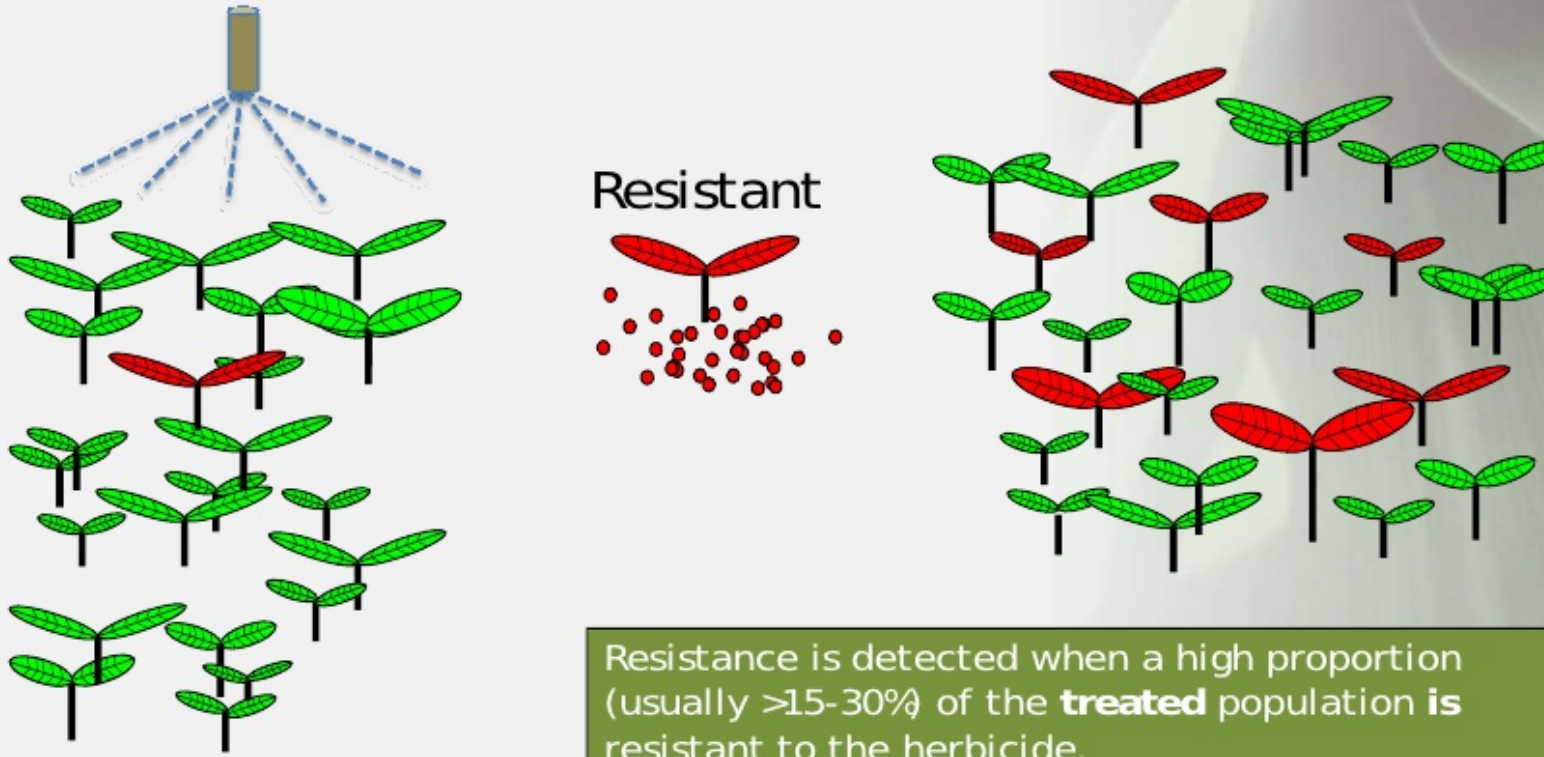
When discussing “GMO safety” we often don’t include the over-use of GMO-compatible herbicides and the consequences.

From the *Environmental Sciences Europe* journal in February 2016:

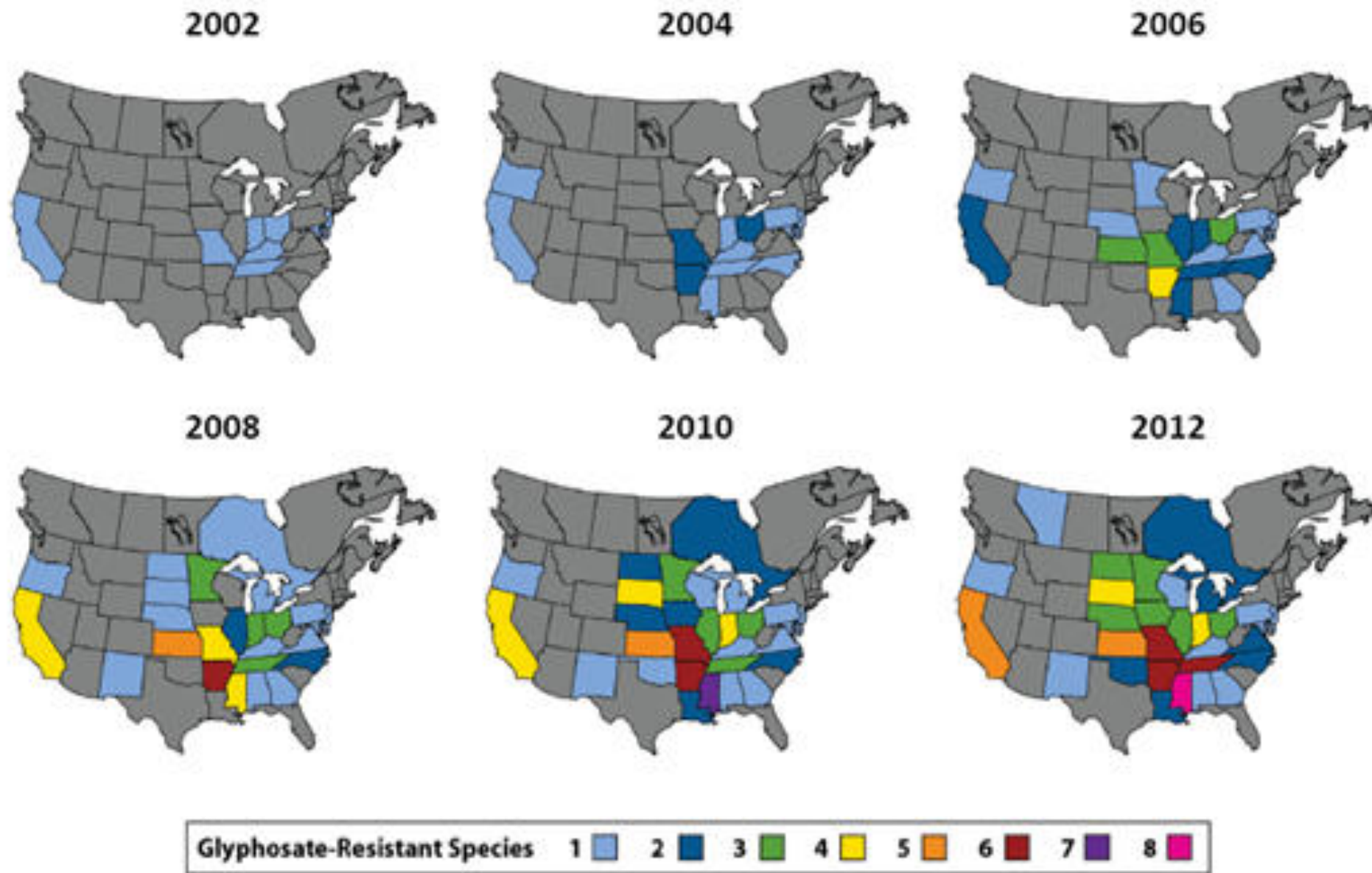
- Glyphosate use has risen **almost 15-fold since so-called “Roundup Ready” genetically engineered crops were introduced in 1996.**
- Remarkably, **74 percent of all glyphosate sprayed on crops since the mid-1970s was applied in just the last 10 years,** as cultivation of GM corn and soybean crops expanded on both US and global croplands.
- To date **18.9 billion lbs. (8.6 billion kg)** of glyphosate have been used globally.

Weed Resistance : Selection pressure

"Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type."



Resistance is detected when a high proportion (usually >15-30%) of the **treated** population is resistant to the herbicide.



The spread of glyphosate weed resistance, 2002 to 2012 (continuing to expand since).



Palmer amaranth,
aka "pigweed",
growing in a field.

Widening the scope of human health



Figure 2: Who is Getting Sick from Pesticide Drift?

Department of Health averages based on data from 2005–2012

56%
Workers on
Another Farm

10%
Workers on
the Same Farm

28%
Nearby
Residents

6%
Other
Bystanders

Source: Washington State Department of Health,
"Agricultural Pesticide Drift and Farmworker Health,"
Farmworker Advisory Committee Meeting, 10/16/2014

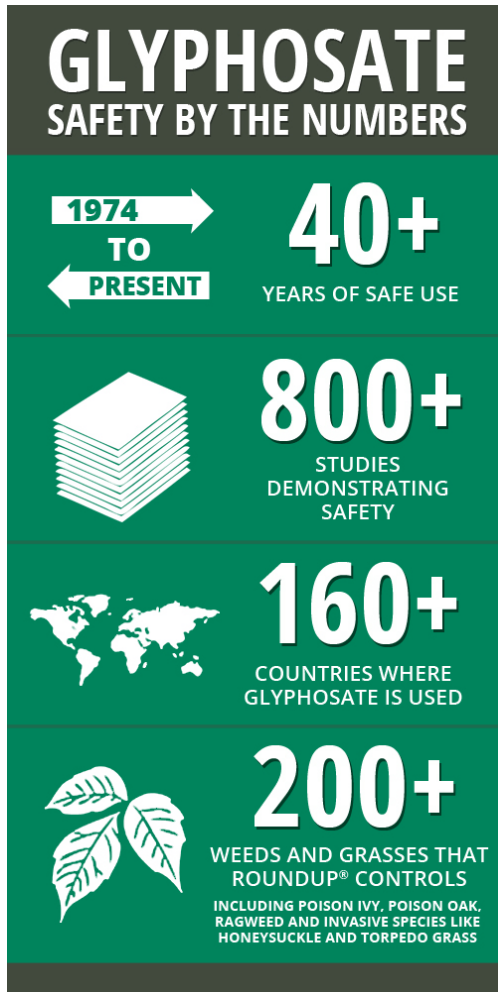
Debates about glyphosate risk

Farmers and regulators assume older agricultural chemicals are safe simply because they've been used for a long time.

From 1989 onward, the US Environmental Protection Agency has classified glyphosate as safe for use, based on rodent studies.

In March 2015, the International Agency for Research on Cancer reclassified glyphosate as “probably carcinogenic”. It used newer epidemiological and laboratory studies that EPA didn’t include in its own assessments.

The emerging glyphosate wars



www.collective-evolution.com

Monsanto Caught Ghostwriting Its Own GMO Safety Reviews For A Stanford Scientist – Collective Evolution

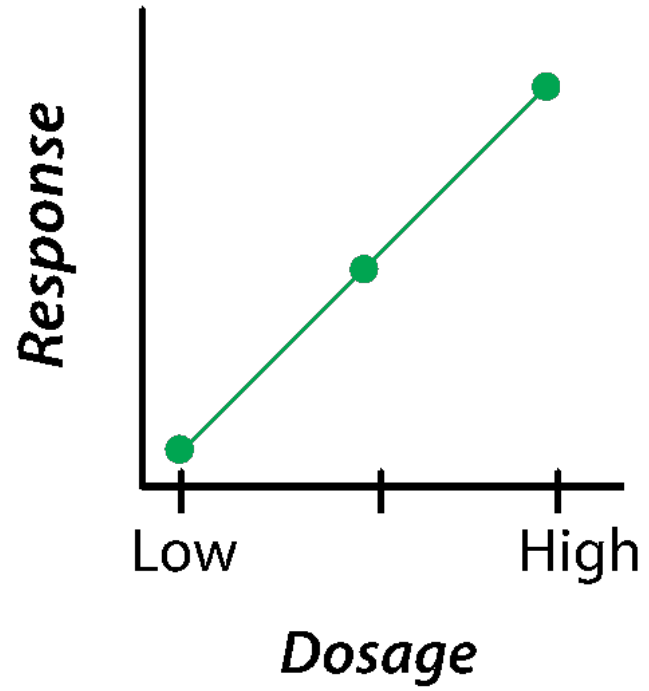
New toxicological precepts

Glyphosate needs to be assessed for a much broader range of health effects: not just cancer but a wide array of reproductive, developmental, and neurological impacts.

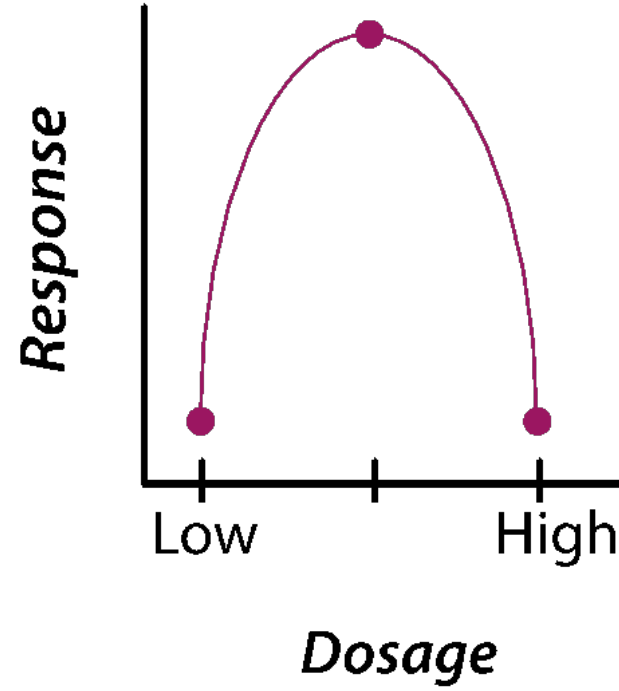
Endocrine-disrupting chemicals can exert their effects at very low doses—something that's dubbed a “non-monotonic curve”.

Yet most studies done on agricultural chemicals mainly look for cancer endpoints, not these other types of health effects. Nor do they look for chronic effects.

A. Monotonic dose response



B. Non-monotonic dose response



Surprises in the diet?

Regulators and seed companies have long argued that glyphosate doesn't even pose any risk to eaters.

That is, there's no connection between what people ingest and what happens on the farm.

Farming practices are changing to include spraying close to harvest times: residues are more likely to stick to crops and enter processed foods.

Glyphosate is now recognized as having a longer half-life in soil: days, months, even a year.

RESEARCH LETTER

Excretion of the Herbicide Glyphosate
in Older Adults Between 1993 and 2016

Paul J. Mills, PhD
Izabela Kania-Korwel, PhD
John Fagan, PhD
Linda K. McEvoy, PhD
Gail A. Laughlin, PhD
Elizabeth Barrett-Connor, MD

“There's a lot of animal work, but few if any on people,” Mills said. “And I was surprised to see that, given how much the chemical is in the environment, and that's what inspired us to just start researching it so we can fill in that gap.”

- San Diego Union-Tribune, October 24.

Table 2. Urinary Excretion Prevalence Rates of Glyphosate and AMPA Among Rancho Bernardo Study Participants Sampled Between 1993 and 2016

Years	Prevalence Rate (95% CI) ^a	
	Glyphosate	AMPA
1993-1996	0.120 (0.064-0.200)	0.050 (0.016-0.113)
1999-2000	0.300 (0.212-0.400)	0.150 (0.086-0.235)
2001-2002	0.430 (0.331-0.533)	0.430 (0.331-0.533)
2004-2005	0.390 (0.294-0.493)	0.400 (0.303-0.503)
2014-2016	0.700 (0.600-0.788)	0.710 (0.611-0.796)

Abbreviation: AMPA, aminomethylphosphonic acid.

^a P value was less than .001.

Undone science

“Areas of research that are left unfunded, incomplete, or generally ignored but that social movements or civil society organizations often identify as worthy of more research.” (Frickel et al. 2011)

There has been systematic *non*production of knowledge regarding agricultural chemicals.

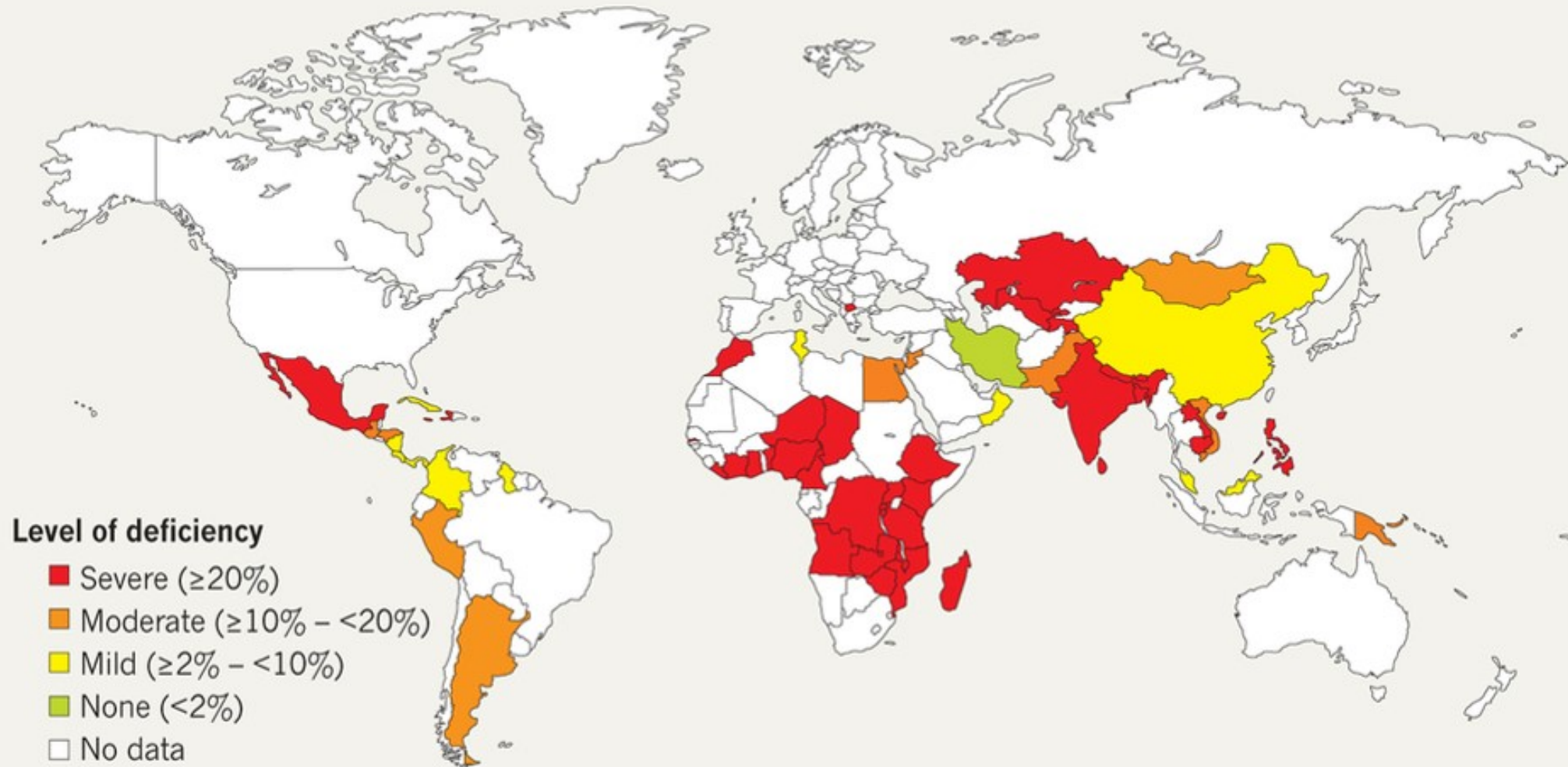
When people say glyphosate is benign, the more rigorous scientific assessment at this moment is clear: we simply do not know.

Case 2: Golden rice



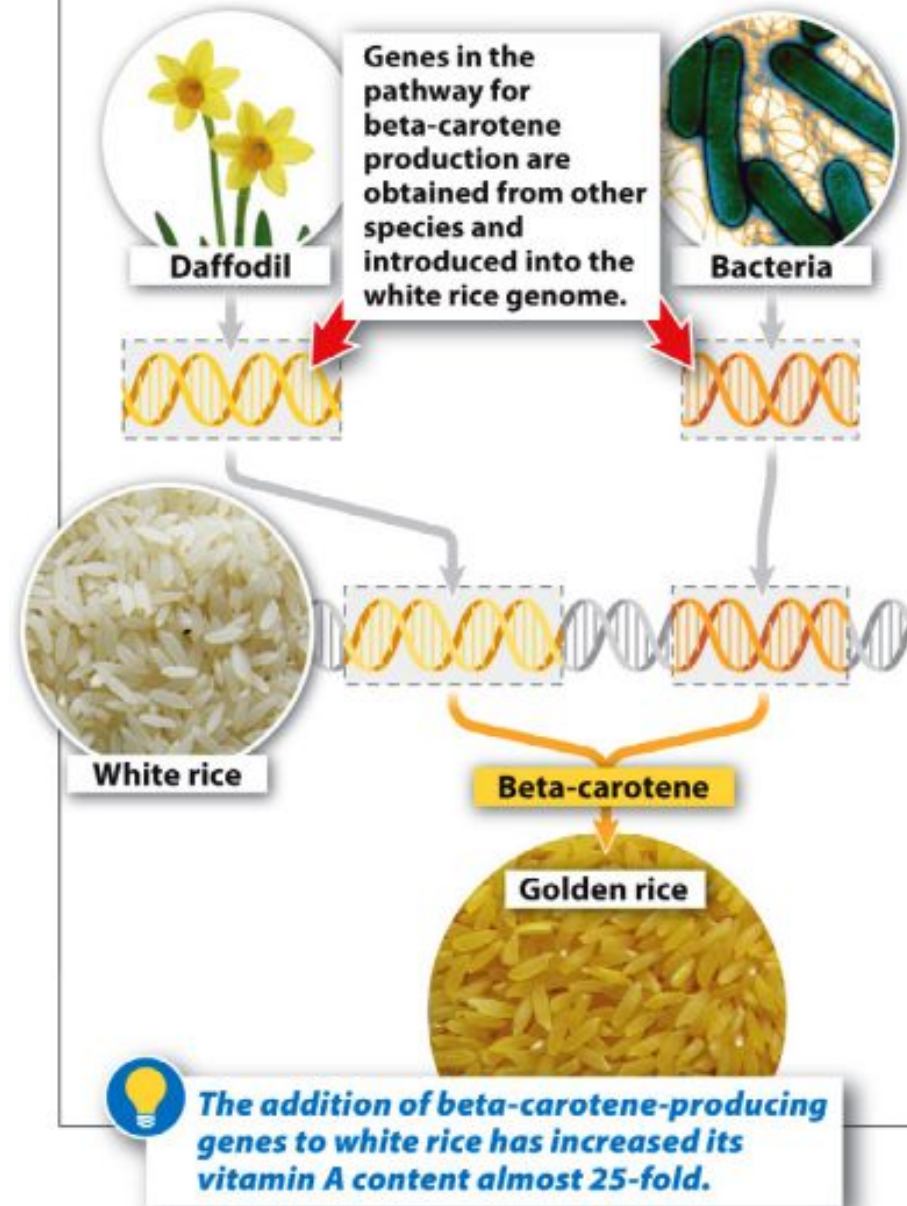
PREVALENCE OF VITAMIN A DEFICIENCY

Map showing level of serum retinol (an indicator of vitamin A deficiency) in pre-school age children. Data were collected by the World Health Organization between 1995 and 2005 from populations at risk.



Estimates of vitamin A deficiency are based on low serum retinol concentration $< 0.70 \mu\text{mol l}^{-1}$

GOLDEN RICE





The International Rice Research Institute, in the Philippines.





Filipino Rice Cultures: Ifugao rice terraces, 300+ traditional varieties adapted to many local agroecosystems.

 <p>MAL GAS Malapatan, Sarangani Province</p>	 <p>MUSLIM Malapatan, Sarangani Province</p>	 <p>LAGFISAN Malapatan, Sarangani Province</p>	 <p>MLAL Malapatan, Sarangani Province</p>
 <p>MLIKAT BLAWEN Malapatan, Sarangani Province</p>	 <p>MORADU Malapatan, Sarangani Province</p>	 <p>M'likat Siawen Sitio Datal Nabut, Brgy. Pagasa, Alabel, Sarangani Province</p>	 <p>Samfang Sitio Datal Nabut, Brgy. Pagasa, Alabel, Sarangani Province</p>
 <p>M'likat Tapol Sitio Datal Nabut, Brgy. Pagasa, Alabel, Sarangani Province</p>	 <p>Paiawan Sitio Balite, Brgy. Alkikan, Malungon, Sarangani Province</p>	 <p>Fantilanen Sitio Datal Nabul, Brgy. Pagasa, Alabel, Sarangani Province</p>	 <p>M'likat Tapol Sitio Datal Bulol, Brgy. Sute Tubo Glan, Sarangani Province</p>

Unintended effects

Scientists *can* efficiently insert genes into rice to enable plants to manufacture more beta-carotene.

pleiotropy”: a gene for one trait influencing seemingly unrelated phenotypic traits.

After 14 years of IRRI’s work, the best varieties still show a “yield drag”, leading to Filipino farmer reluctance to use them.

As of 2016, IRRI admitted at least 3 to 5 more years of breeding would be needed.

Molecular and Functional Characterization of GR2-R1 Event Based Backcross Derived Lines of Golden Rice in the Genetic Background of a Mega Rice Variety Swarna

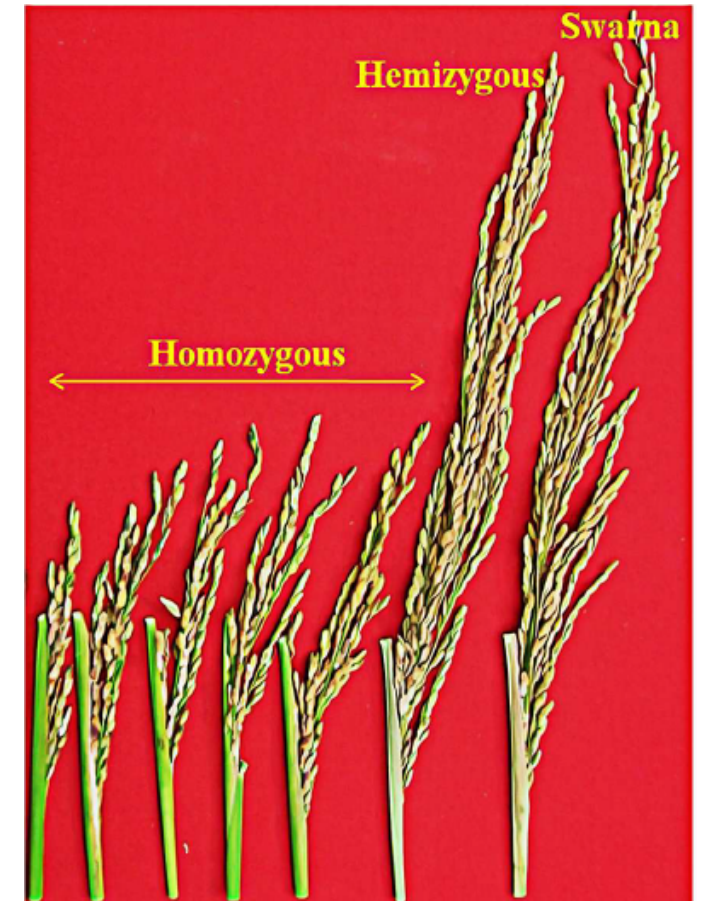
Haritha Bollinedi¹, Gopala Krishnan S.¹, Kumble Vinod Prabhu¹, Nagendra Kumar Singh², Sushma Mishra³, Jitendra P. Khurana³, Ashok Kumar Singh^{1*}

¹ Division of Genetics, ICAR-Indian Agricultural Research Institute, New Delhi, Delhi, India, ² ICAR-National Research Centre on Plant Biotechnology, Pusa Campus, New Delhi, Delhi, India, ³ Department of Plant Molecular Biology, University of Delhi, South Campus, New Delhi, Delhi, India



A = golden rice bred into Swarna

D = Swarna



Ignoring the "root causes" of malnutrition?

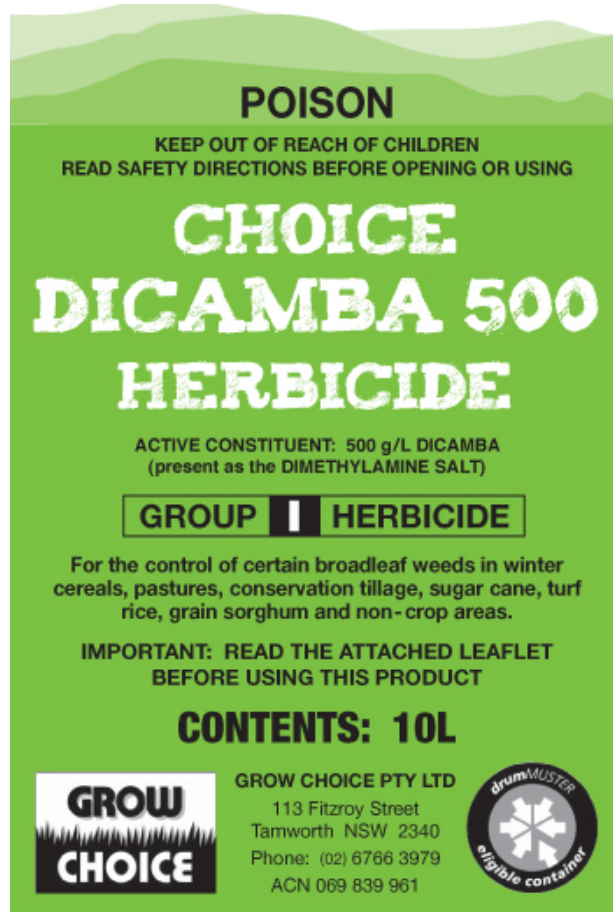
Vitamin-A deficiency seems to be declining around the world even *without* golden rice intervention.

Nutrition programs have brought the incidence of childhood VAD from a peak of 40% in 2003 to 15% in 2008. (Glenn Davis Stone, 2016).

VAD is really a problem of compromised immune systems.

VAD's damaging effect comes from, and is exacerbated by, gaps in public health infrastructure and overall nutrition.

Case 3: Dicamba



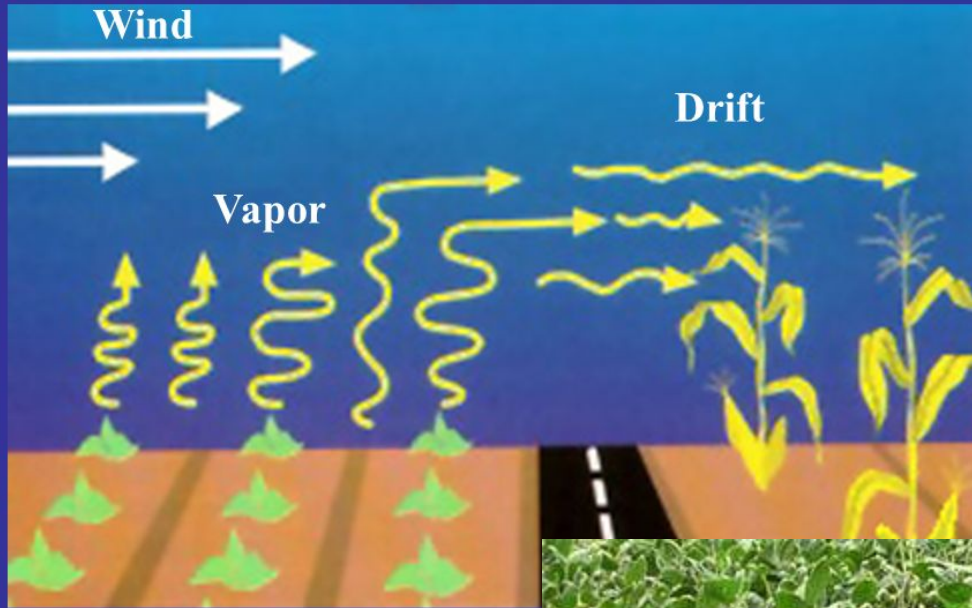
Rapidly spreading weed resistance to glyphosate across the US South and Midwest.

Many farmers are seeking alternative herbicides to survive.

Normally, dicamba will kill soybean and cotton plants.

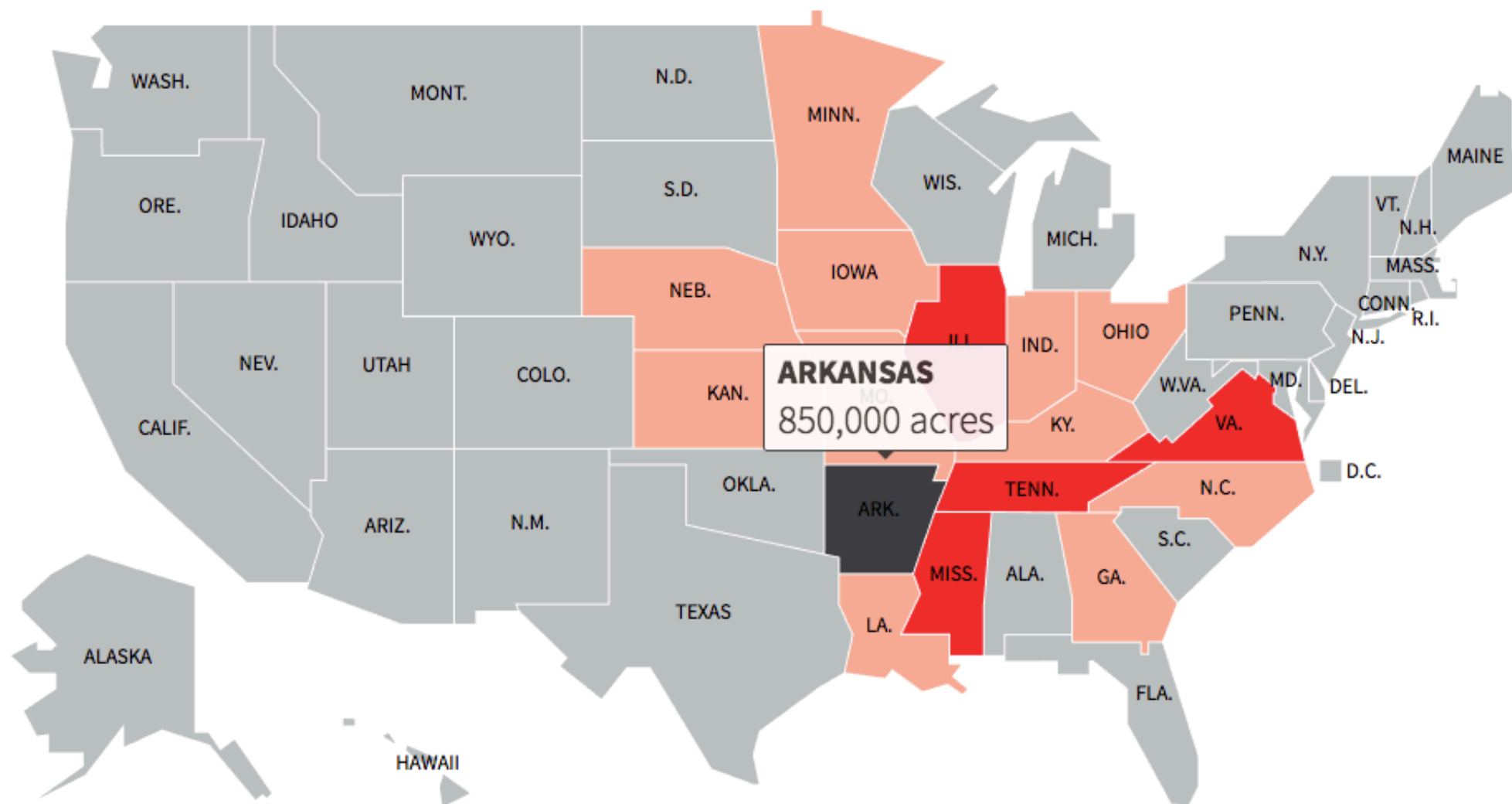
Monsanto and BASF developed GM cotton and soybean seeds that survive applications of dicamba.

Vapor drift can occur even days after the application



ESTIMATES OF DICAMBA-INJURED SOYBEAN ACREAGE BY STATE

■ No data available* ■ Less than 250,000 ■ 250,000-500,000 ■ 500,000 or more



So what went wrong?

1. *A chemistry problem:* Dicamba is known to be highly volatile. The seed companies didn't have their new, low-volatility Dicamba formulation publicly verified.
2. *A timing problem:* the companies began selling the GMO seeds before the low-volatility dicamba was even approved.
3. *A science suppression problem:* weed scientists began finding volatilization – a pattern of evaporating and spreading. But when they told Monsanto, they were ignored.

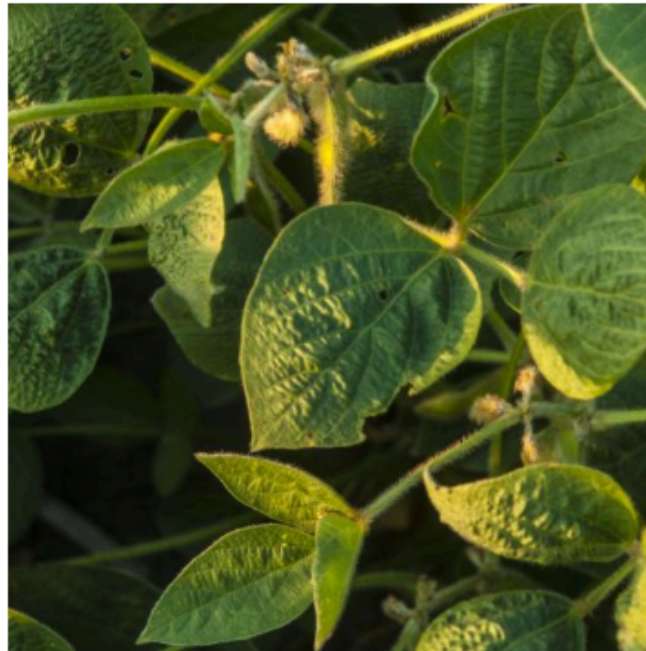
MONSANTO LEVELS CRITICISM AT ARKANSAS WEED SCIENTISTS

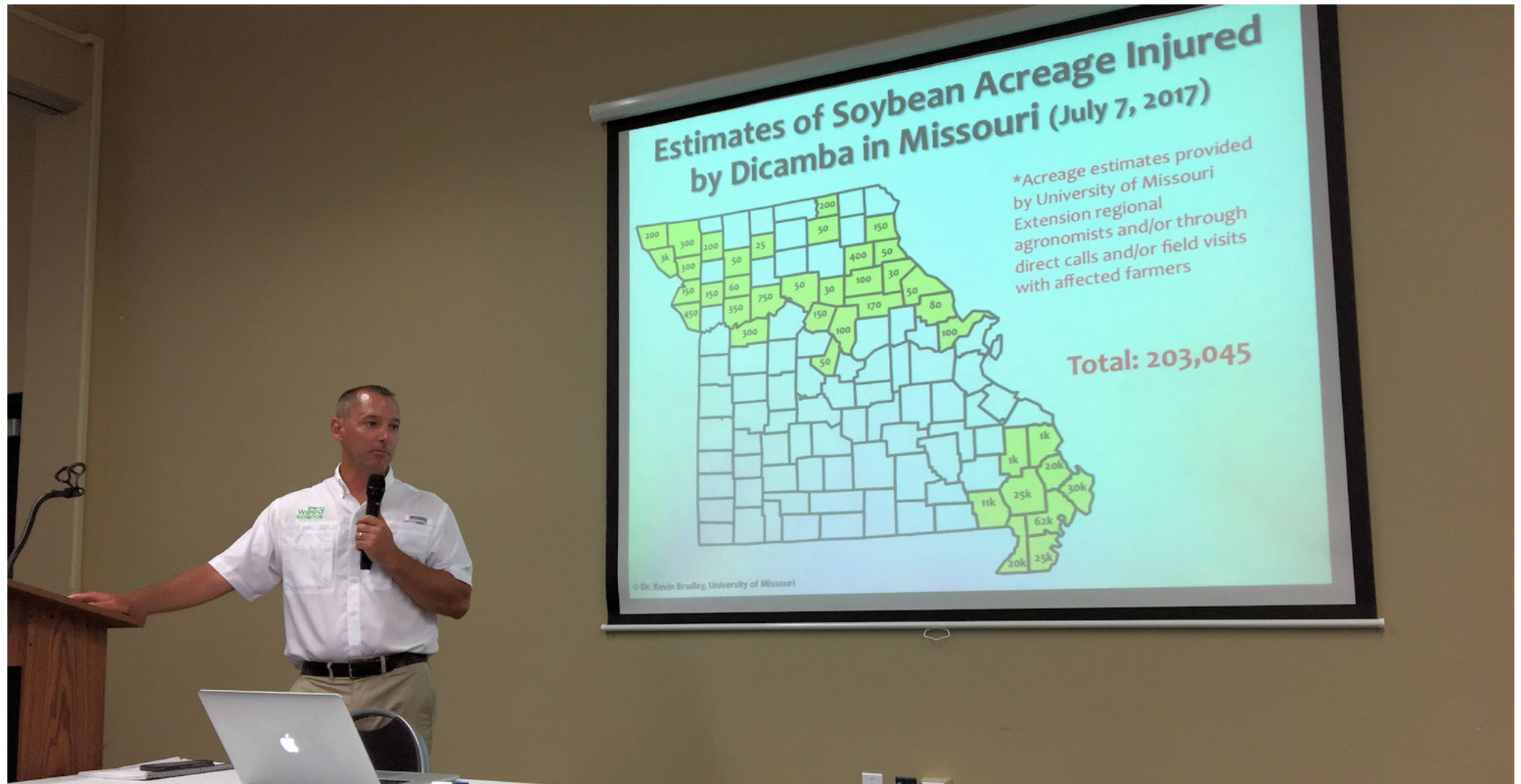
“SAD DAY IN WEED SCIENCE,” SAYS ONE EXTENSION WEED SCIENTIST

By [Gil Gullickson](#)
9/11/2017

Monsanto has taken off the gloves in its effort to advance its dicamba-tolerant technology. Last week, the St. Louis-headquartered firm filed a [petition with the Arkansas State Plant Board](#) to halt what it calls an “unwarranted and misinformed ban” on dicamba in Arkansas.

Within that petition, they criticized the efforts of two well-known Arkansas weed scientists—Ford Baldwin and Jason Norsworthy. Baldwin is a retired University of Arkansas (U of A) Extension weed scientist who now does consulting work. Norsworthy is a U of A weed scientist.





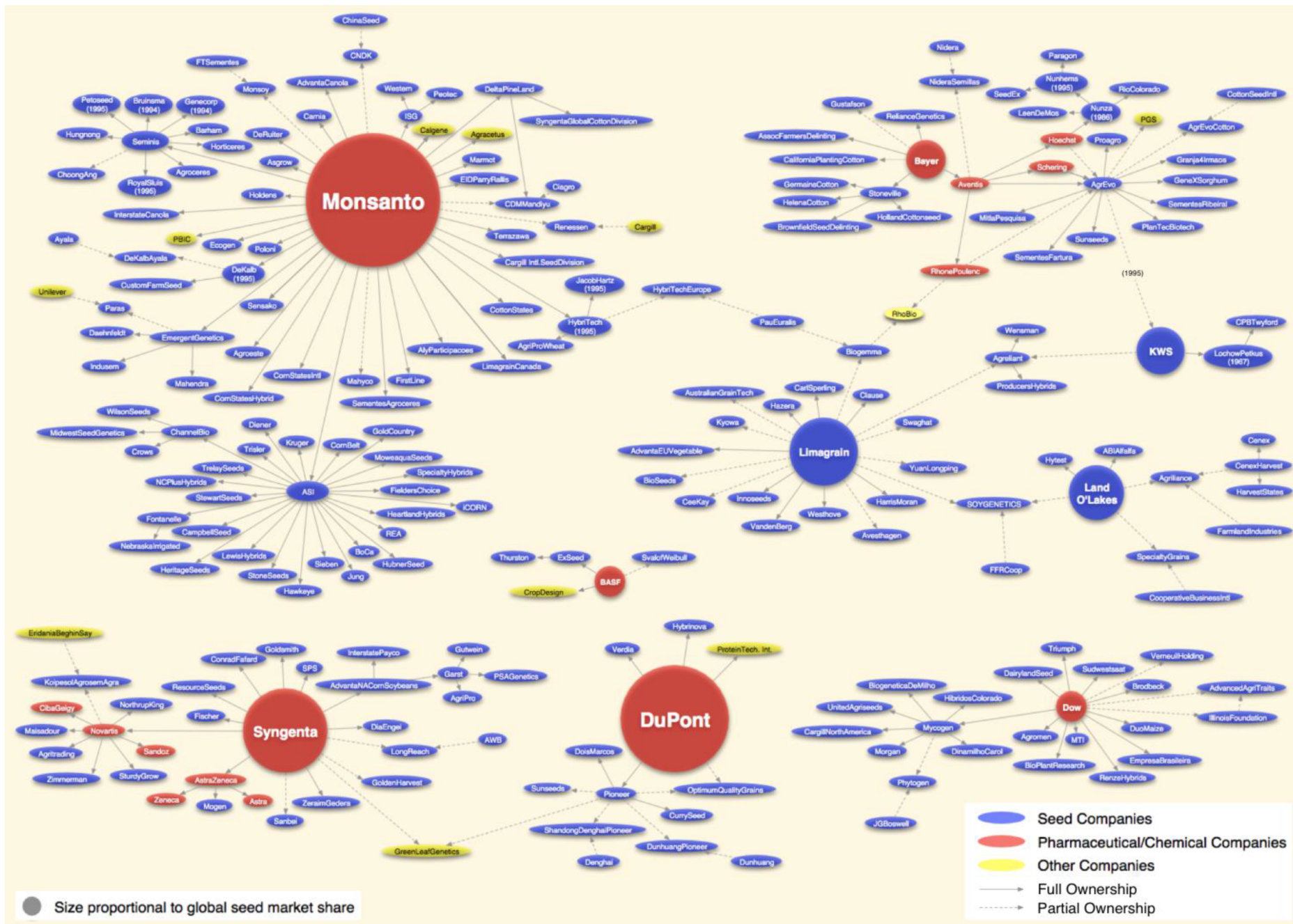
University of Missouri weed scientist Kevin Bryant reporting back on dicamba damage trends.

Unanswered questions

Why didn't Monsanto, BASF, and DuPont do proper studies to see whether or not the new dicamba formulation was still highly volatile?

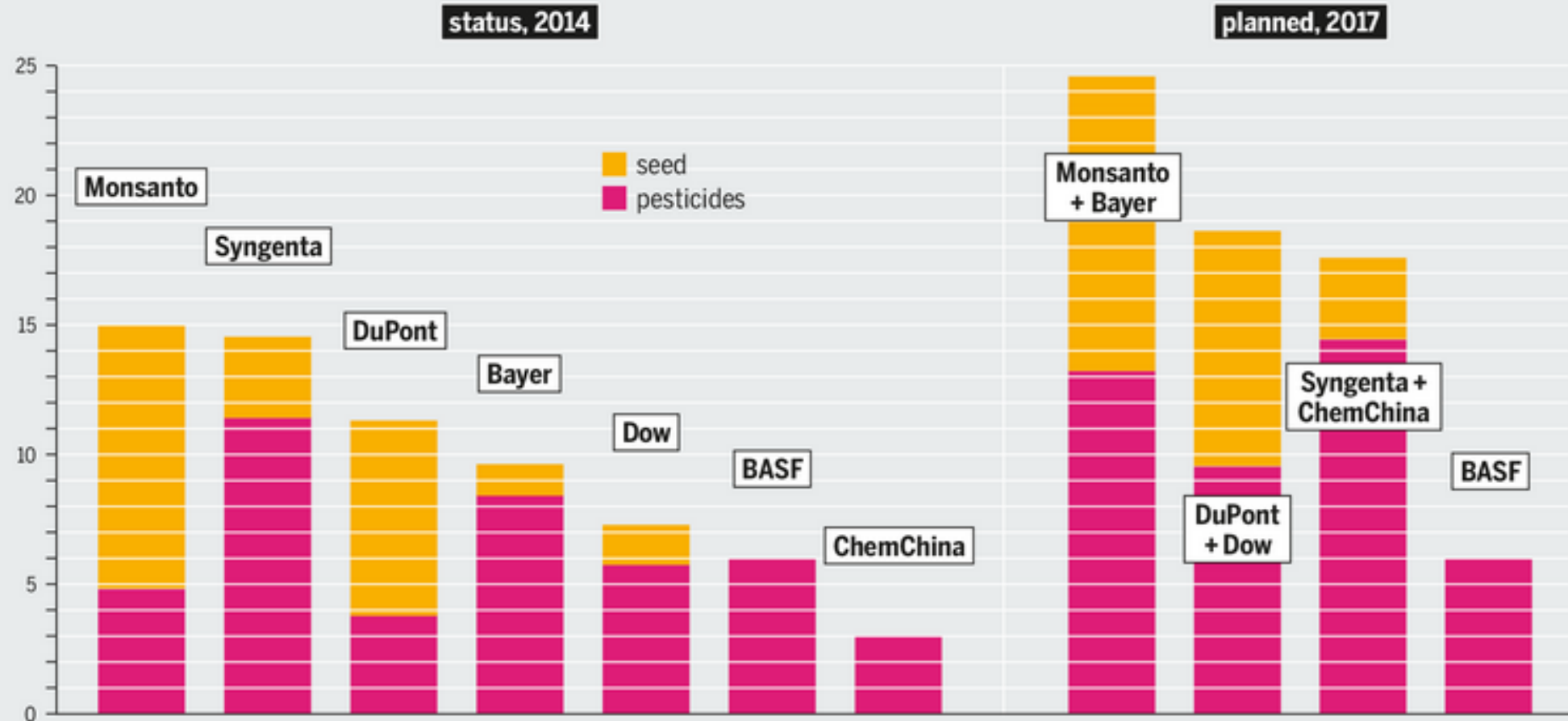
Why didn't these companies wait until they had actually secured regulatory approval?

Why didn't the companies provide full data to regulators, scientists, and the public?



BUY TO SQUEEZE OUT THE COMPETITION

Concentration of the world's biggest agrochemicals companies, 2014 turnover, without merger-related sell-offs, in billion US dollars



Mergers of Monsanto-Bayer, Dow-Dupont, and Syngenta-ChemChina mean 'titanic 3' control: **65% of agri-chemical market** and **61 % of commercial seed supply** globally.

Concluding Thoughts

We think GM crops could be part of sustainable agriculture systems.

But: we need to expand our analytical perspective:

- how can GM crops support health of rural communities & eaters?
- how can farmers & consumers have real decision-making power?
- are there alternative solutions that offer lower-hanging fruit?

Think first about building an agroecological food system that is just, sustainable, and people-centered.

Selected key references

- Agrifood Atlas. 2017. *The Agrifood Atlas. Published Jointly by Heinrich Boll Foundation, Rosa Luxemburg Foundation, and Friends of the Earth Europe*. Eds, C. Chemnitz (HBF), B. Luis
- Andreotti, G., Koutros, S., Hofmann, J. N., Sandler, D. P., Lubin, J. H., Lynch, C. F., ... & Silverman, D. T. (2017). Glyphosate Use and Cancer Incidence in the Agricultural Health Study. *JNCI: Journal of the National Cancer Institute*.
- Benbrook, Charles M. 2016. "Trends in glyphosate herbicide use in the United States and globally." *Environmental Sciences Europe* 28.1:3.
- Charles, Dan. 2017. Monsanto Attacks Scientists After Studies Show Trouble for Weedkiller Dicamba, NPR, October 26.
- ETC. 2015. "Breaking Bad: Big Ag Mega-Mergers in Play." ETC Group Communiqué, December. http://www.etcgroup.org/sites/www.etcgroup.org/files/files/etc_breakbad_23dec15.pdf.
- Hakim, Danny. 2016. Doubts About the Bounty of Genetically Modified Crops, New York Times, October 29.
- Howard, P.H. 2009. Visualizing Consolidation in the Global Seed Industry: 1996–2008. *Sustainability* 1, no. 4: 1266–87.
- Glenn Davis Stone. 2015 "[Golden Rice: Bringing a Superfood Down to Earth](#)," *Field Questions Blog*, August 28.
- Mills, P. J., Kania-Korwel, I., Fagan, J., McEvoy, L. K., Laughlin, G. A., & Barrett-Connor, E. (2017). Excretion of the Herbicide Glyphosate in Older Adults Between 1993 and 2016. *Jama*, 318(16), 1610-1611.
- Mooney P. R. et al. 2016. "Merge-Santo: New Threat to Food Sovereignty." Briefing Note. Canada: ETC Group, March 23.
- Myers, J. P., Antoniou, M. N., Blumberg, B., Carroll, L., Colborn, T., Everett, L. G., ... & Vandenberg, L. N. (2016). Concerns over use of glyphosate-based herbicides and risks associated with exposures: a consensus statement. *Environmental Health*, 15(1), 19.

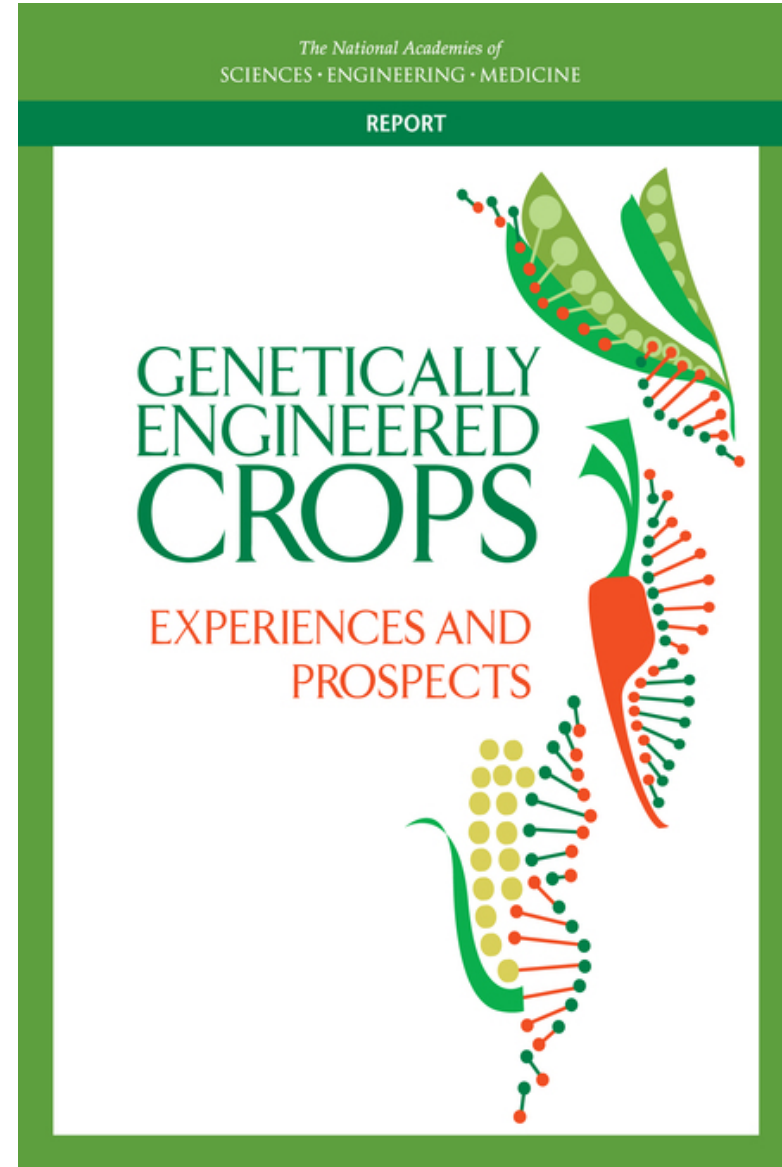
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YIELD & ECONOMICS

National Academy of Sciences [report](#) found “**there was little evidence**” that **introduction of genetically modified crops in the United States have led to yield gains** beyond those seen in conventional crops.

GE crops have not contributed to measurable increases in crop yield or even “**readily identifiable economic benefits**” for many farmers.





OXFORD

JNCI J Natl Cancer Inst (2018) 110(5): djx233

doi: 10.1093/jnci/djx233

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Article

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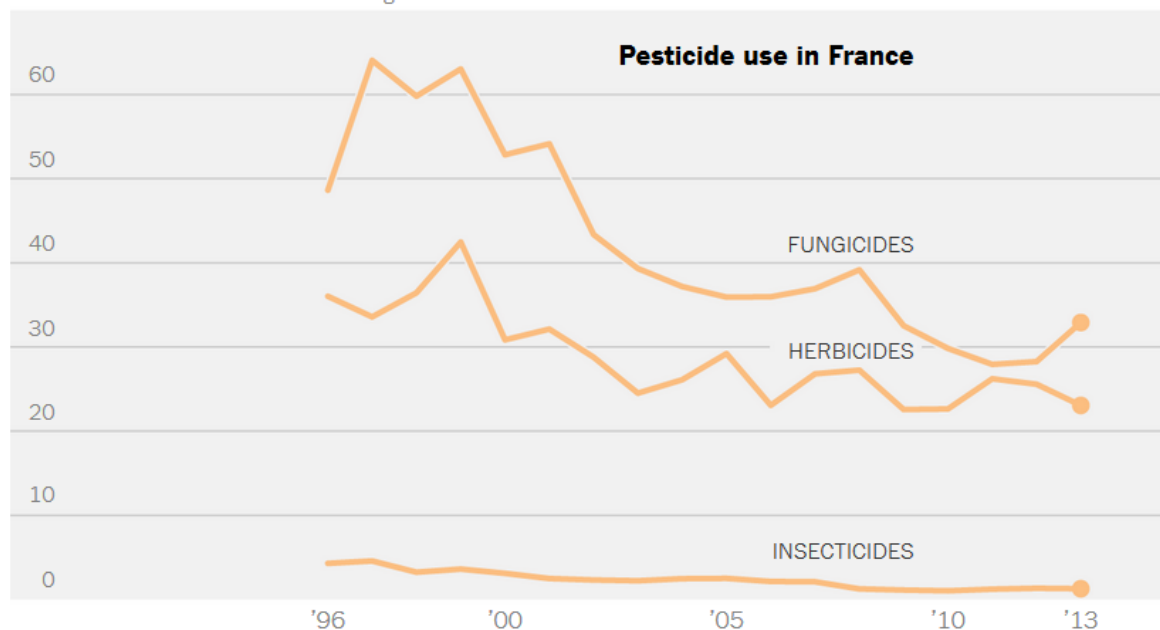
Glyphosate Use and Cancer Incidence in the Agricultural Health Study

Gabriella Andreotti, Stella Koutros, Jonathan N. Hofmann, Dale P. Sandler,
Jay H. Lubin, Charles F. Lynch, Catherine C. Lerro, Anneclaire J. De Roos,
Christine G. Parks, Michael C. Alavanja, Debra T. Silverman,
Laura E. Beane Freeman

G.M.O.s Were Supposed to Lessen Pesticide Use

Manufacturers also said that genetically modified crops would reduce the need for pesticides. In France, where G.M.O.s are not permitted, pesticide use has significantly declined.

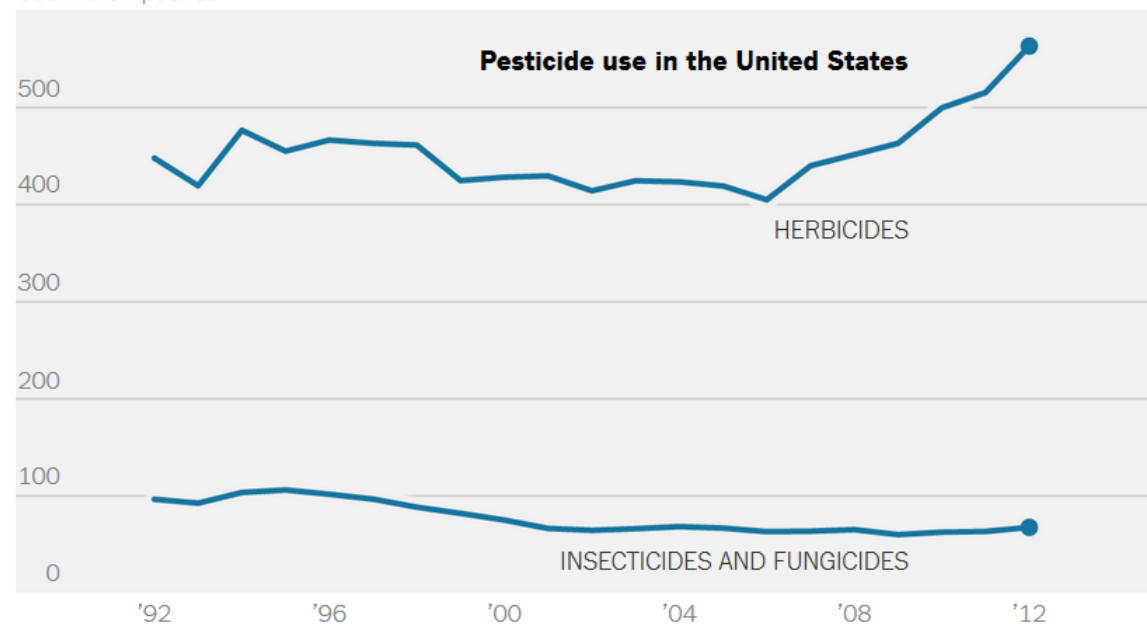
70 thousand metric tons of active ingredient



The New York Times | Source: Union of Industries of Plant Protection (France)

But in the United States, while the use of insect- and fungus-killing chemicals has declined, farmers are using even more weed killers.

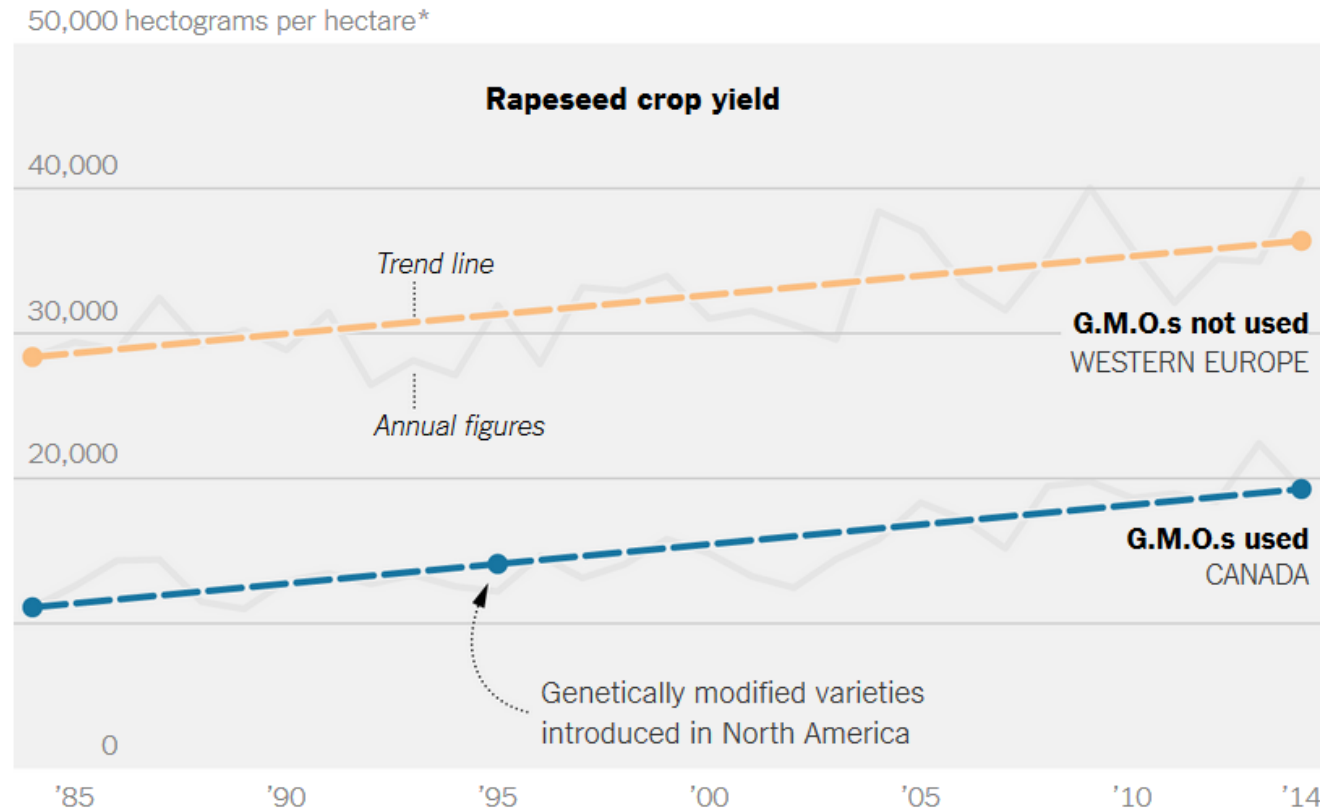
600 million pounds



The New York Times | Source: U.S. Geological Survey

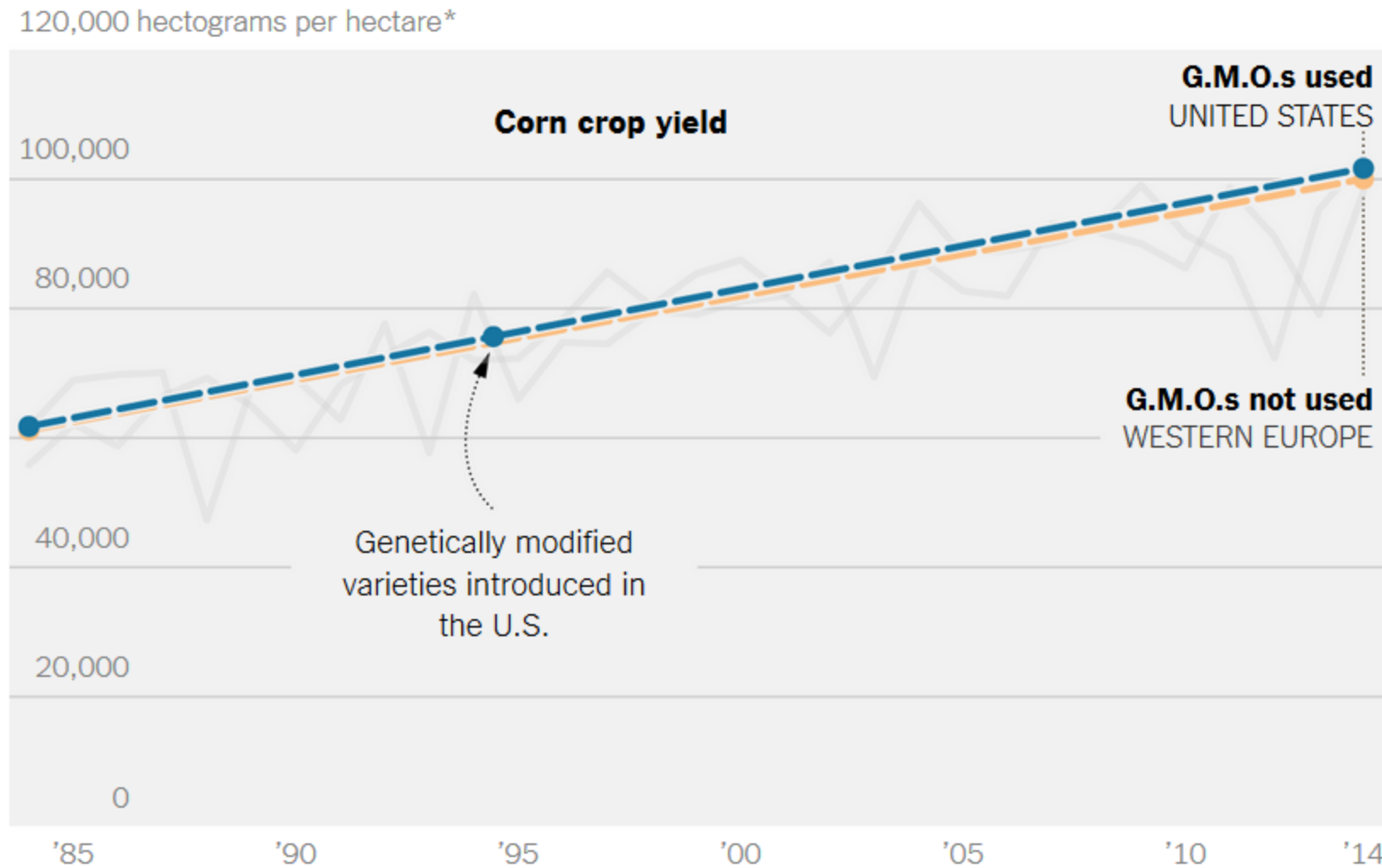
G.M.O.s Were Supposed to Increase Crop Yields

Canada and Western Europe grow different varieties of rapeseed (canola), but Canadian farmers have adopted genetically modified seed, while European farmers have not. Still, the long-term yield trend for both areas is up.



The New York Times | Sources: Food and Agriculture Organization of the United Nations | Note: Western Europe is France, Germany, Belgium, Luxembourg, Switzerland, the Netherlands and Austria.

In the last three decades, corn yields in Western Europe have largely kept pace with those in the United States.



The New York Times | Source: Food and Agriculture Organization of the United Nations | Note: Western Europe is France, Germany, Belgium, Luxembourg, Switzerland, the Netherlands and Austria.



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FEATURE REVIEW

Diversifying Food Systems in the Pursuit of Sustainable Food Production and Healthy Diets

Sangam L. Dwivedi, Edith T. Lammerts van Bueren, Salvatore Ceccarelli, Stefania Grando, Hari D. Upadhyaya, Rodomiro Ortiz

Published Online: July 14, 2017

Publication stage: In Press Corrected Proof

Diverse and healthy diets, largely based on plant-derived food, may reduce diet-related illnesses.

Investments in plant sciences will be necessary to design diverse cropping systems balancing productivity, sustainability, and nutritional quality. Cultivar diversity and nutritional quality are crucial. We call for better cooperation between food and medical scientists, food sector industries, breeders, and farmers to develop diversified and nutritious cultivars that reduce soil degradation and dependence on external inputs, such as fertilizers and pesticides, and to increase adaptation to climate change and resistance to emerging pests.

‘Root Cause’ problem?

Data between 1970 and 2012
for 116 countries showed:

Increased productivity only
about **18% of the decrease in
hunger** since 1970

Key drivers of reductions:

- Safe water access & sanitation
- Women’s education & gender equality



World Development

Volume 68, April 2015, Pages 180-204



Reducing Child Undernutrition: Past Drivers and Priorities for the Post-MDG Era

Lisa C. Smith ^a, Lawrence Haddad ^b

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<https://doi.org/10.1016/j.worlddev.2014.11.014>

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How Monsanto Captured the EPA (And Twisted Science) To Keep Glyphosate on the Market

Since 1973, Monsanto has cited dubious science, like tests on the uteri of male mice, and the EPA has let much of it slide.

VALERIE BROWN AND ELIZABETH GROSSMAN




Stephan Neidenbach

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Jul 13 · 3 min read

 Recta

PHD candidate failed to disclose activist connection in letter attacking science film



A Berkeley University PHD candidate wrote a widely publicized letter attacking the science documentary [Food Evolution](#) last month ([signed by more than 40 other academics](#)) at the behest of the very groups exposed in the film, without disclosing her connection, emails released on [Muckrock.com](https://muckrock.com) show.

These groups (Pesticide Action Network, Center for Food Safety, Small Planet Institute, and Friends of the Earth) all



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