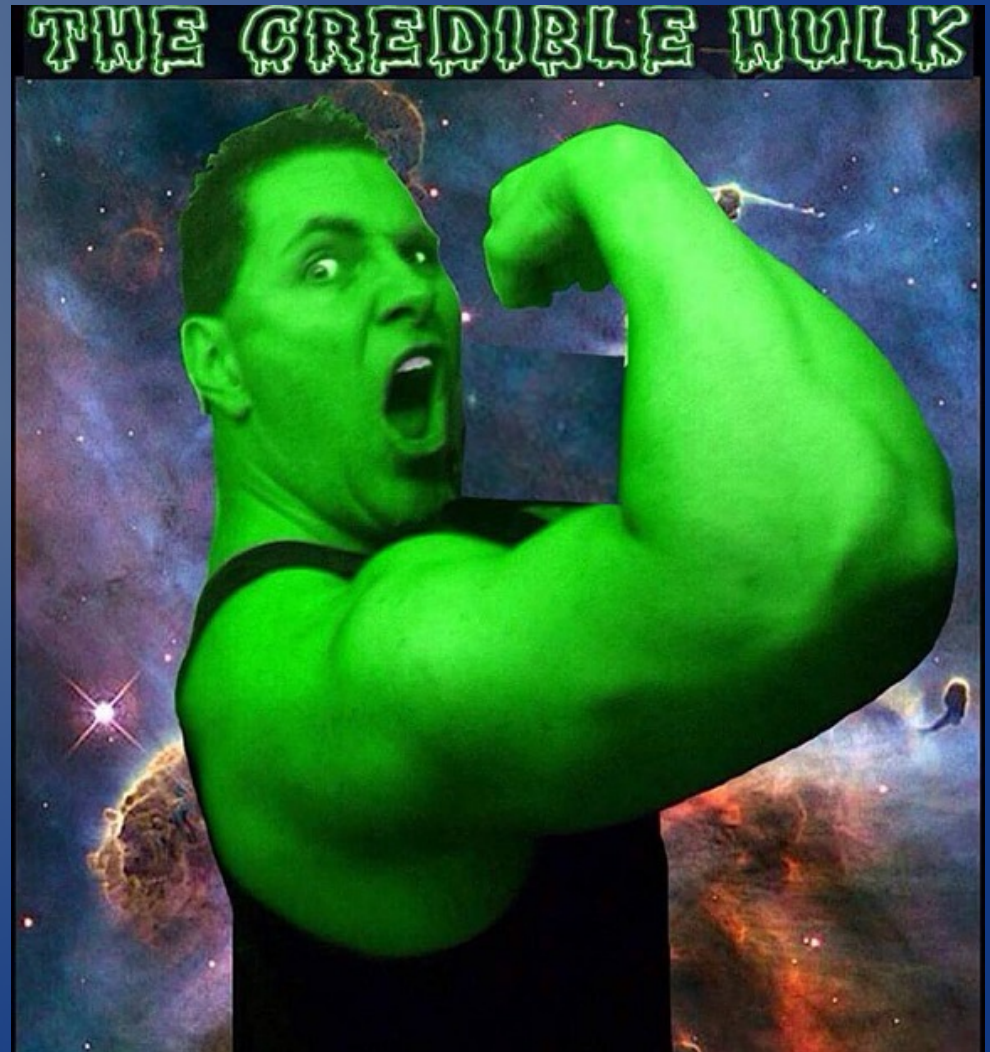


Genetically Engineered Food Opposition: the Gap between Science and Public Perception



Matthew Lee Loftus: Admin of The Credible Hulk blog and FB page



Genetically Engineered Food Opposition: the Gap between Science and Public Perception



Why is the GMO Food Debate a Great Topic for Skeptics?

- It's a mainstream topic (not fringe)
- It has important implications for society
- It involves an overlap of many complex logical, social, and scientific issues to sort through
- It is rife with misinformation, vehemently polarized opinions, and motivated reasoning

What Counts as a GE Organism?

Crop Modification Techniques

Cross Breeding

Combining two sexually compatible species to create a variety with the desired traits of the parents



The Honeycrisp Apple gets its famous texture and flavor by blending the traits of its parents.

Mutagenesis

Use of mutagens such as radioactivity to induce random mutations, creating the desired trait



Radiation was used to produce a deeper color in the red grapefruit.

Polyploidy

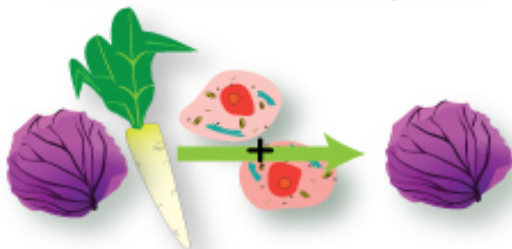
Multiplication of the number of chromosomes in a crop to impact its fertility



Seedless watermelons are created by crossing a plant with 2 sets of chromosomes with another that has 4 sets. The seedless fruit has 3 sets.

Protoplast Fusion

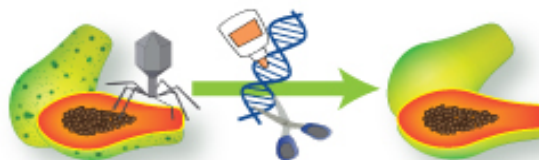
Fusion of cells or cell components to transfer traits between species



Male sterility is transferred from radishes to red cabbage by fusing their cells. Male sterility helps plant breeders make hybrid crops.

Transgenesis

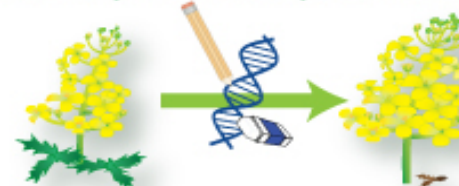
Addition of genes from any species to create a new variety with desired traits



The Rainbow Papaya is modified with a gene that gives it resistance to the Papaya Ringspot Virus.

Genome Editing

Use of an enzyme system to modify DNA directly within the cell



Genome editing was used to develop herbicide resistant canola to help farmers control weeds.

www.biofortified.org

Follow us on Twitter (@frankfoode) or join our Facebook Page

By Layla Katiraei (@BiochicaGMO) in collaboration with Karl Haro von Mogel (@kjhwm)

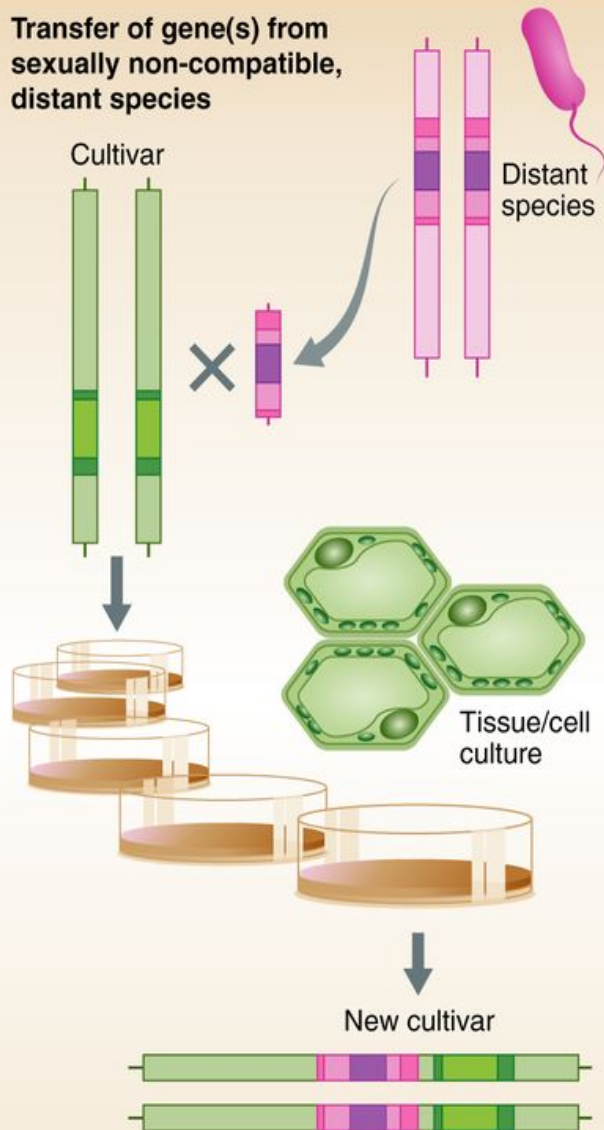
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What Counts as a GE Organism?

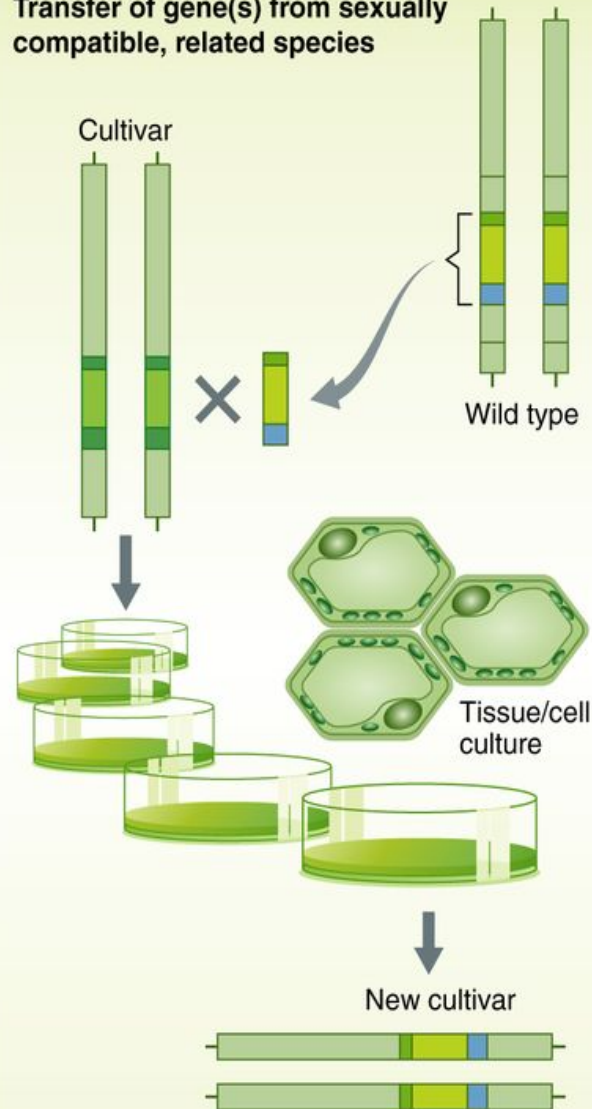
TRANSGENIC

Transfer of gene(s) from sexually non-compatible, distant species



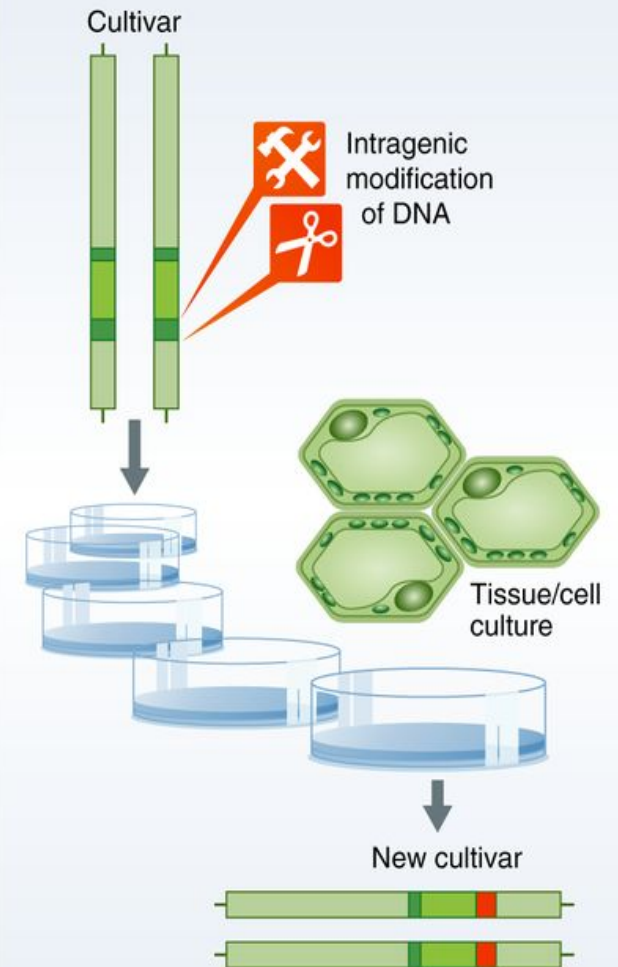
CISGENIC

Transfer of gene(s) from sexually compatible, related species



INTRAGENIC

Direct modification of target genes or gene expression via regulatory RNAs, e.g., gene silencing via short hairpin RNAs (shRNAs)



For What Purposes?

Trait Examples:

- Insect Tolerance (i.e. Bt Corn)
- Herbicide Tolerance (i.e. glyphosate-resistant Soy)
- Virus Resistance (i.e. ringspot-resistant papaya)
- Extended shelf life (i.e. delayed browning in arctic apple)
- Drought Resistance (drought-resistant corn and sweet corn)
- Biofortification (golden rice)

Golden Rice



Golden Rice

- An estimated $\frac{1}{4}$ – $\frac{1}{2}$ million children go blind due to vitamin A deficiency per year
- About $\frac{1}{2}$ of them die within a year of going blind
- The Golden Rice project is an effort to use Vit. A fortified GE rice to combat Vit. A deficiency
- Rice is a daily staple food in many regions most affected by this, therefore implementation of GR should not require major infrastructural changes
- GR licensing agreements are free for humanitarian purposes

Biotechnology and Climate Change:

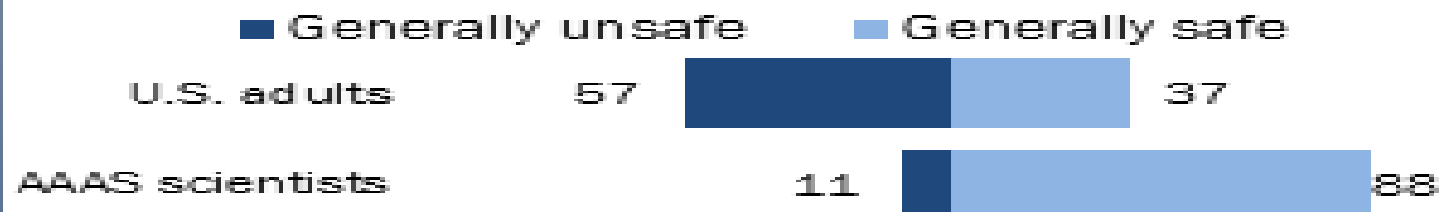


- Agricultural Biotechnology provides tools with which to cope with climate change
- As climate change progresses, GE traits conferring resistance to heat, drought & salinity will likely become increasingly important

PEW Reports: Views of Scientists vs Public Perception:

Wide Differences Between Public and Scientists on Safety of GM Foods

% of each group saying it is generally safe or unsafe to eat genetically modified foods



Public Largely Skeptical of Scientific Understanding of Health Effects

% of U.S. adults saying that scientists have or do not have a clear understanding about the health effects of GM crops



Survey of U.S. adults August 15-25, 2014. Q38-39. AAAS scientists survey Sept. 11-Oct. 13, 2014. Other responses and those saying don't know or giving no answer are not shown.

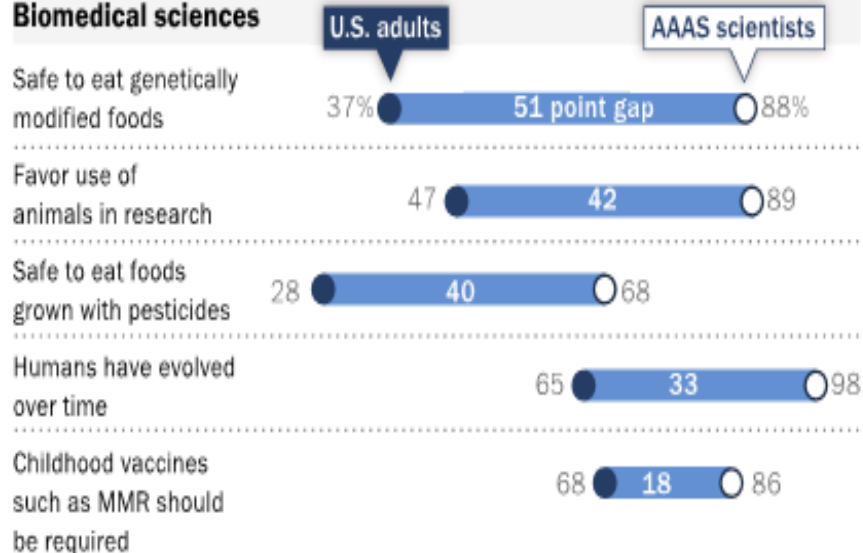
PEW RESEARCH CENTER

Opinion Differences Between Public and Scientists by Topic:

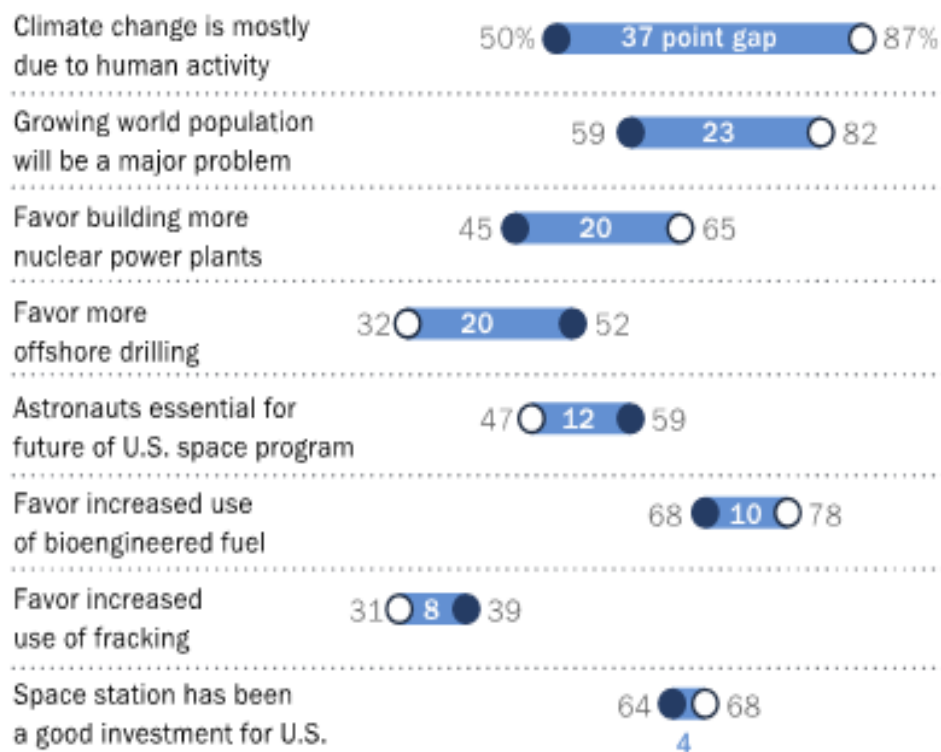
Opinion Differences Between Public and Scientists

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

Biomedical sciences



Climate, energy, space sciences



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

How Have GE Foods Been Portrayed?



How Have GE Foods Been Portrayed to the Public?



Public Image

heh heh heh they never know I poison da
apple with science liquid

-Dr.Monsanto



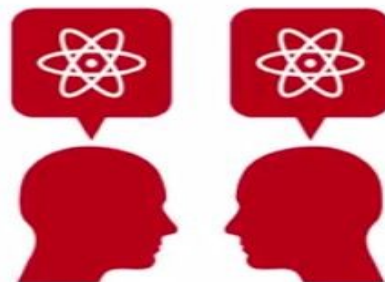
Scientific Consensus

- Involves many independent lines of quality evidence converging on the same and/or complimentary conclusions.
- Likely exists when scientific knowledge is the best explanation for a given consensus, which occurs when the following criteria are satisfied:

**Consilience
of Evidence**



**Social
Calibration**



**Social
Diversity**



Consilience of Evidence

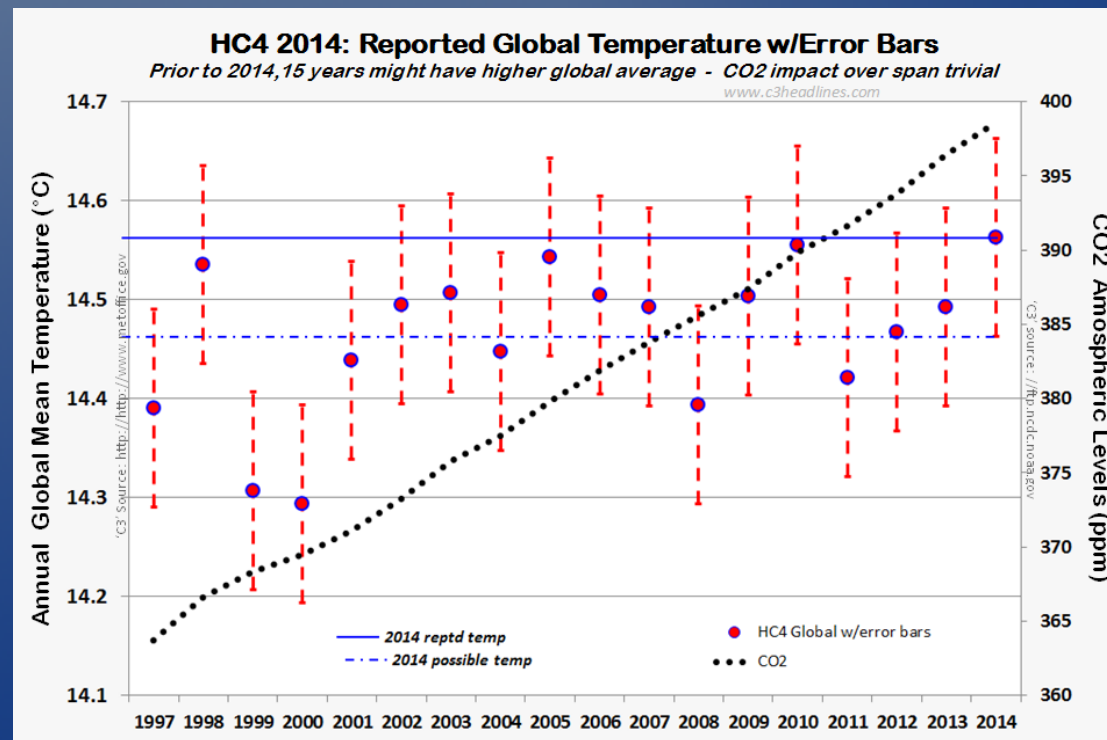


- Must be based on varied lines of evidence independently converging on the same &/or complimentary conclusions
- Does not necessarily imply absolute 100% unanimity
- Scientists needn't necessarily agree on every minute detail
- Data Convergence may fall within error bars

Consilience of Evidence



- Data Convergence may fall within error bars

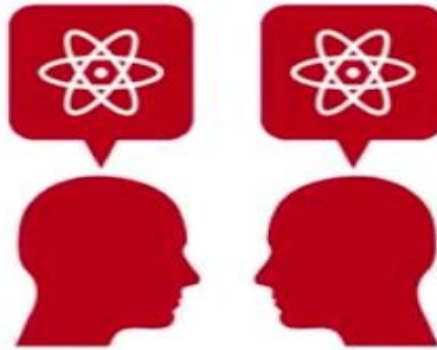


Consilience of Evidence



- Must be based on varied lines of evidence independently converging on the same &/or complimentary conclusions
- Does not necessarily imply unanimity
- Scientists needn't necessarily agree on every minute detail
- Data Convergence may fall within error bars
- But must point to same general conclusions even if debates still exist on the minutia

Social Calibration



- Experts mutually committed to the same high standards of evidence and formalisms
- Evidence doesn't talk. It has to be interpreted by scientists
- This criterion is about what the scientific community accepts as evidence, how they decide what's significant, and how individuals convince peers of their conclusions

Social Diversity



- The evidence and analyses should come from varied sources by scientists of varied backgrounds and funding sources to avoid systematic biases in the literature
- This criterion ensures that a consensus is not a result of group think, politics, financial incentives, ideological motives, or shared cultural values.

Consilience of Evidence



- Thousands of studies underlie the scientific consensus on GE foods

Scientific Consensus on GE Foods

- All currently approved GE crops have been tested on a case-by-case basis and the weight of the evidence suggests they are at least as safe as their closest non-GE counterparts.
- Nothing about the process makes unpredicted dangers any more intrinsically likely with modern molecular GE techniques than other methods of altering an organism's genome.

Systematic Reviews

- “Results from all the 24 studies do not suggest any health hazards and, in general, there were no statistically significant differences within parameters observed. However, some small differences were observed, though these fell within the normal variation range of the considered parameter and thus had no biological or toxicological significance. If required, a 90-day feeding study performed in rodents, according to the OECD Test Guideline, is generally considered sufficient in order to evaluate the health effects of GM feed. The studies reviewed present evidence to show that GM plants are nutritionally equivalent to their non-GM counterparts and can be safely used in food and feed.”
- **Snell, C., Bernheim, A., Bergé, J. B., Kuntz, M., Pascal, G., Paris, A., & Ricroch, A. E. (2012). Assessment of the health impact of GM plant diets in long-term and multigenerational animal feeding trials: a literature review. Food and Chemical toxicology, 50(3), 1134-1148.**

1,783 Study Systematic Review

- “We have reviewed the scientific literature on GE crop safety for the last 10 years that catches the scientific consensus matured since GE plants became widely cultivated worldwide, and we can conclude that the scientific research conducted so far has not detected any significant hazard directly connected with the use of GM crops.”
- **Nicolia, A., Manzo, A., Veronesi, F., & Rosellini, D. (2014). An overview of the last 10 years of genetically engineered crop safety research. Critical reviews in biotechnology, 34(1), 77-88.**

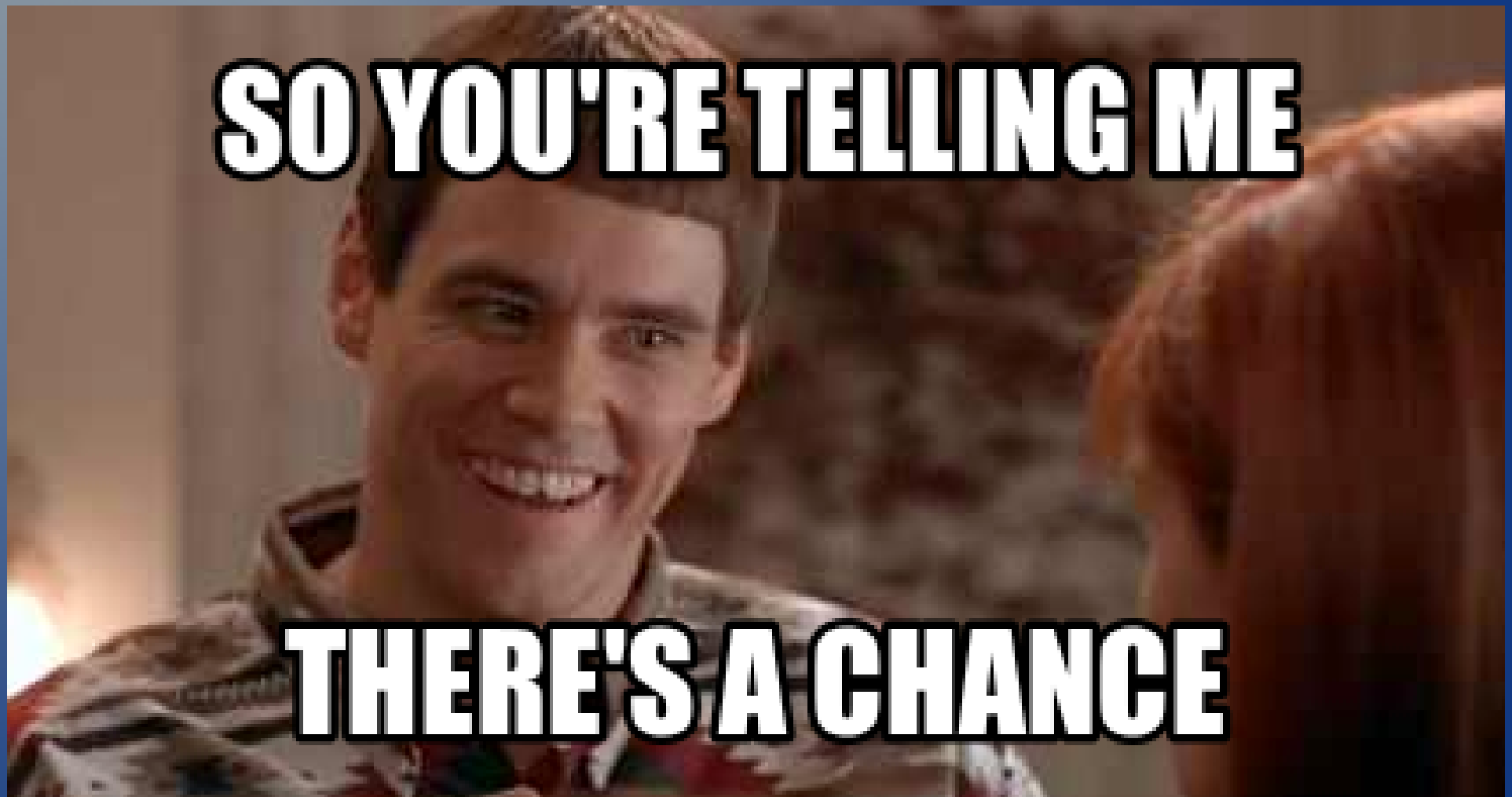
18 Year 100 Billion Animal Study

- “These field data sets, representing over 100 billion animals following the introduction of GE crops, did not reveal unfavorable or perturbed trends in livestock health and productivity. No study has revealed any differences in the nutritional profile of animal products derived from GE-fed animals.”
- Van Eenennaam, A. L., & Young, A. E. (2014). Prevalence and impacts of genetically engineered feedstuffs on livestock populations. *Journal of Animal Science*, 92(10), 4255-4278.

Unintended Compositional Changes

- All known breeding methods are capable of resulting in off-target changes
- A small portion of these may be undesirable
- These occur at lower frequencies with GE
- For regulatory reasons, such rare cases are less likely to make it into the food supply with GE than with non-GE

Unintended Compositional Changes



Compositional Equivalence

- **“It is concluded that suspect unintended compositional effects that could be caused by genetic modification have not materialized on the basis of this substantial literature.”**
- **Herman, R. A., & Price, W. D. (2013). Unintended compositional changes in genetically modified (GM) crops: 20 years of research. Journal of agricultural and food chemistry, 61(48), 11695-11701.**

GE Results in Fewer Off-Target Mutations than Mutagenesis

- Transgenesis resulted in an order of magnitude fewer off-target structural changes to the genome than mutagenesis
- Anderson, J. E., Michno, J. M., Kono, T. J., Stec, A. O., Campbell, B. W., Curtin, S. J., & Stupar, R. M. (2016). Genomic variation and DNA repair associated with soybean transgenesis: a comparison to cultivars and mutagenized plants. *BMC biotechnology*, 16(1), 41.



Expression of other genes is less affected by GE than by Mutagenesis

- This study found that transcriptome alteration was greater in mutagenic breeding than with transgenesis
- Despite this, seeds arrived at via mutagenesis undergo no safety evaluation or substantial equivalence testing whatsoever prior to commercialization
- A coherent justification for this regulatory double standard has not been forthcoming
- **Batista, R., Saibo, N., Lourenço, T., & Oliveira, M. M. (2008). Microarray analyses reveal that plant mutagenesis may induce more transcriptomic changes than transgene insertion. Proceedings of the National Academy of Sciences, 105(9), 3640-3645.T**

Composition & Gene Expression Impacted Less by GE than by Conventional Breeding

- Used multiple ‘-omics’ comparisons (transcriptomics, proteomics, metabolomics)
- Transgenesis had *less* impact on plant gene expression & composition than conventional plant breeding
- Environmental factors had greater impacts than transgenesis
- **Ricroch, A. E. (2013). Assessment of GE food safety using ‘-omics’ techniques and long-term animal feeding studies. *New Biotechnology*, 30(4).**

Harmful &/or Undesired Results From Conventional Breeding

- Lenape potato: excessive solanine
- Kiwi allergen
- Cucurbitacin poisoning from Zucchini
- Celery cultivars with high psoralens expression
- Jadhav, S. J., Sharma, R. P., & Salunkhe, D. K. (1981). Naturally occurring toxic alkaloids in foods. *CRC Critical reviews in toxicology*, 9(1), 21-104.
- Kerzl, R., Simonowa, A., Ring, J., Ollert, M., & Mempel, M. (2007). Life-threatening anaphylaxis to kiwi fruit: protective sublingual allergen immunotherapy effect persists even after discontinuation. *Journal of allergy and clinical immunology*, 119(2), 507-508.
- National Academies of Sciences, Engineering, and Medicine. (2017). *Genetically engineered crops: experiences and prospects*. National Academies Press.

- “Because GE crops are regulated to a greater degree than are conventionally bred, non-GE crops, it is more likely that traits with potentially hazardous characteristics will not pass early developmental phases.”
- “For the same reason, it is also more likely that unintentional, potentially hazardous changes will be noticed before commercialization either by the breeding institution or by governmental regulatory agencies.”

National Research Council. (2004). Safety of genetically engineered foods: Approaches to assessing unintended health effects. National Academies Press.

SCIENTIFIC CONSENSUS

Biotechnology

The American Association for the Advancement of Science

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."

Climate Change

"The scientific evidence is clear: global climate change caused by human activities is occurring now, and it is a growing threat to society."

The National Academy of Sciences

"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."

"The scientific understanding of climate change is now sufficiently clear to justify taking steps to reduce the amount of greenhouse gases in the atmosphere."

The American Medical Association

"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."

"AMA supports the findings of the IPCC's fourth assessment report and concurs with the scientific consensus that the Earth is undergoing adverse global climate change and that anthropogenic contributions are significant."

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 the international non-profit organization of scientists and academies of science. AAAS serves some 251 affiliated societies and academies of science.

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."



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 38 million acres of genetically modified crops have been planted in the United States. No human health problems associated with the ingestion of these crops or resulting food products have been identified."



The American Council on Science and Health is a non-profit group of scientists dedicated to ensuring that important public policies related to health and the environment have a sound scientific basis.

"With the continuing accumulation of evidence of safety and efficacy, and the complete absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology."



The ASM represents over 42,000 microbiologists worldwide.

"The ASM is not aware of any acceptable evidence that food produced with biotechnology and subject to FDA oversight constitutes a health risk. The ASM is sufficiently convinced to assure the public that the safety of foods and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life."

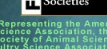


The Science Source for Food, Agriculture, and Environmental Issues.

CAST is a nonprofit organization composed of scientific societies and many individual, student, company, nonprofit, and academic scientists.

"Over the last decade, 8.5 million farmers have grown transgenic varieties of crops on more than 1 billion acres of farmland in 17 countries. These crops have been consumed by humans and animals in most countries."

Transgenic crops on the market today are as safe to eat as their conventional counterparts, and likely more so given the greater regulatory scrutiny to which they are exposed."



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

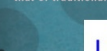
"Meat, milk and eggs from livestock and poultry consuming biotech feeds are safe for human consumption."



Creating a Safer and Healthier World by Advancing the Science of Toxicology.

The Society of Toxicology is a professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology.

"Scientific analysis of the process of GM food production is different nature than those already familiar to toxicologists. The level of safety of current GM foods to consumers appears to be equivalent to that of traditional foods."



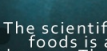
The Union of German Academies of Sciences and Humanities is an umbrella organization for eight German academies of sciences and humanities.

"In consuming food derived from GM plants approved by the EU and in the USA, the risk is in no way higher than in the consumption of food from conventionally grown plants. On the contrary, in some cases food from GM plants appears to be superior in respect to health."



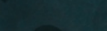
The International Council for Science (ICSU) is an international non-governmental organization devoted to the advancement of science. Its members are national scientific bodies and international scientific organizations.

"Currently available genetically modified crops – and foods derived from them – have been judged safe to eat, and the methods used to test them have been deemed appropriate."



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 European Commission (EC) is the executive body of the European Union.

"The main conclusion to be drawn from the efforts of more than 150 research projects over a period of more than 22 years of research, and involving more than 100 independent research groups, is that GM foods are no more risky than e.g. conventional breeding technologies."

The American Society for Cell Biology is an international community of biologists dedicated to advancing scientific discovery, advocating sound research policies and improving education.

"Far from presenting a threat to the public health, GM crops in many cases improve it. The ASCB vigorously supports research and development in the area of genetically engineered organisms, including the development of genetically modified (GM) crop plants."

The Crop Science Society of America (CSSA) is a prominent international scientific society dedicated to the conservation and wise use of natural resources to produce food, feed, and fiber crops while maintaining and improving the environment.

"The Crop Science Society of America supports education and research in all aspects of crop production, including the judicious application of biotechnology."

The SIFAB has one of the largest groups of crop geneticists and biotechnologists in the world among its membership.

"All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product, prior to their use by the public."

Consensus Statement on GMOs, representing 14 Italian scientific societies.

"GMOs on the market today, having successfully passed all the tests and procedures necessary for authorization, are to be considered, on the basis of current knowledge, to be safe for use in human and animal foods."

The French academy of science is resolutely committed to the advancement of science and has advised government authorities in these matters and issues deemed within its remit.

"All criticisms against GMOs can be largely rejected on strictly scientific criteria."

• The WHO:

"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 American Society for Cell Biology:

"Far from presenting a threat to the public health, GM crops in many cases improve it. The ASCB vigorously supports research and development in the area of genetically engineered organisms, including the development of genetically modified (GM) crop plants."

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



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"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."



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 \$8 million acres of genetically modified crops have been grown in the United States. No human health problems associated with the ingestion of these crops or resulting food products have been identified."



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"With the continuing accumulation of evidence of safety and efficacy and the complete absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology."



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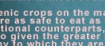
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UNION DER DEUTSCHEN AKADEMIE DER WISSENSCHAFTEN

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Bioengineered foods have been consumed for close to 20 years, and no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."



England's top medical society, the Royal Society of Medicine is an independent educational organization for doctors, dentists, scientists and others involved in medicine and health.

"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 ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."



American Society of Plant Sciences is a professional society devoted to the advancement of the plant sciences.

"The risks of unintended consequences of gene transfer are comparable to the random mixing of genes during classical breeding. The ASPS believes responsible regulation and oversight, as with all plants, is a significant health and environmental benefit to the world and its people."



The Crop Science Society of America (CSSA) is a non-profit international scientific society dedicated to the conservation and wise use of natural resources to produce food, feed, and fiber crops while maintaining and improving the environment.

"The Crop Science Society of America supports education and research in all aspects of crop production, including the judicious application of biotechnology."



The SCS has one the largest group of crop geneticists and biotechnologists in the world among its membership.

"All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product, prior to their use by the public."



The Society of Food Safety is a non-profit organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice food safety.

"Foods can be produced through the use of GM technology that are more nutritious, stable in storage, and in principle health promoting—bringing benefits to consumers in both industrialized and developing nations."



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."



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"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."



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The International Seed Foundation facilitates the international movement of seed, related information and technology.

"The safety of genetically modified plant varieties is assured through a most rigorous and comprehensive set of regulatory and quality assurance systems."



The International Society of African Scientists (ISAS) is a non-profit organization with the aim of solving the technical problems facing countries primarily in Africa and the Caribbean.

"Africa and the Caribbean cannot afford to be left further behind in acquiring the uses and benefits of this new agricultural revolution."



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"Currently available genetically modified crops – and foods derived from them – have been judged safe to eat, and the methods used to test them have been deemed appropriate."

• The EU commission's 18 year research project concluded the following:

“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 not per se more risky than e.g. conventional plant breeding technologies.” (page 16).

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?

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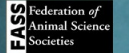
The American Council on Science and Health is a non-profit group of scientists dedicated to ensuring that important public policies related to health and the environment have a sound scientific basis. "With the continuing accumulation of evidence of safety and efficiency and the complete absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology."



The ASM represents over 42,000 microbiologists worldwide. "The ASM is not aware of any acceptable evidence that food produced with biotechnology and subject to FDA oversight constitutes a health risk or is unsafe. We are sufficiently convinced to assure the public that the safety of the products created with biotechnology have the potential to improve nutrition, better taste and longer shelf-life."



CAST is a nonprofit organization composed of scientific societies and many individual, student, company, nonprofit, and academic society. "Over the last decade, 8.5 million farmers have grown transgenic varieties of crops on more than 1 billion acres of farmland in 17 countries. These crops have been consumed by humans and animals in most countries. Transgenic crops on the market today are as safe to eat as their conventional counterparts and likely more so given the greater regulatory scrutiny to which they are exposed."



Representing the American Dairy Science Association, the American Society of Animal Science, and the Poultry Science Association members. "Meat, milk and eggs from livestock and poultry consumed in biotech feeds are safe for human consumption."



The Society of Toxicology is a professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology. "Scientists agree that the process of GM food production is different from that of traditional food production. The safety of current GM foods to consumers appears to be equivalent to that of traditional foods."



The Union of German Academies of Sciences and Humanities is an umbrella organization for eight German academies of sciences and humanities. "In consuming food derived from GM plants approved in the EU and in the USA, the risk is in no way higher than in the consumption of food from conventionally grown plants. On the contrary, in some cases food from GM plants appears to be superior in respect to health."



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England's top medical society, the independent educational organization for doctors, dentists, scientists and others involved in medicine and health. "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 ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."



American Society of Plant Sciences is a professional society devoted to the advancement of the plant sciences. "The risks of unintended consequences of the transfer of genes are comparable to the random mixing of genes that occurs during classical breeding. The ASPS believes responsible regulation and oversight, both from safety and significant health and environmental benefits to the world and its people."



The Crop Science Society of America (CSSA) is a professional scientific society dedicated to the conservation and use of natural resources to produce food, feed, and fiber crops while maintaining and improving the environment. "The Crop Science Society of America supports education and research in all aspects of crop production, including the judicious application of biotechnology."



The SIFCB has one of the largest groups of crop scientists and biotechnologists in the world among its membership. "All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product prior to their use by the public."



Prepared by the Royal Society of London, the US National Academy of Sciences, the Chinese Academy of Sciences, the Indian National Science Academy, the Mexican Academy of Sciences and the World Academy of Sciences. "Foods can be produced through the use of GM technology that are more nutritious, stable in storage, and in principle health promoting—bringing benefits to consumers in both industrialized and developing nations."



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 European Commission (EC) is the executive body of the European Union. "The main conclusion to be drawn from the efforts of more than 150 research projects over a period of more than 22 years of research and involving more than 50 independent research groups, is that biotechnology, and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."



The American Society for Cell Biology is an international community of biologists dedicated to advancing scientific discovery, advocating sound research policies and improving education. "Far from presenting a threat to the public health, GM crops in many cases improve it. The ASCB vigorously supports research and development in the area of genetically engineered organisms, including the development of genetically modified (GM) crop plants."



The International Seed Foundation facilitates the international movement of seed, related know-how and technology. "The safety of genetically modified plant varieties is assured through a most rigorous and comprehensive set of regulatory and quality assurance systems."



The International Society of African Scientists (ISAS) is a non-profit organization with the aim of solving the technical problems facing countries primarily in Africa and the Caribbean. "Africa and the Caribbean cannot afford to be left further behind in acquiring the uses and benefits of this new agricultural revolution."



Consensus statement on GMO's representing 14 Italian scientific societies. "GMOs on the market today, having successfully passed all the tests and procedures necessary for authorization, are to be considered, on the basis of current knowledge, to be safe for use in human and animal foods."



The French academy of science is resolutely committed to the advancement of science and has advised government authorities in those matters and issues deemed within its remit. "All criticisms against GMOs can be largely rejected on strictly scientific criteria."



The International Council for Science (ICSU) is an international non-governmental organization devoted to the advancement of science. Its members are national scientific bodies and international scientific unions. "Currently available genetically modified crops – and foods derived from them – have been judged safe to eat, and the methods used to test them have been deemed appropriate."

• The American Council on Science and Health: "[W]ith the continuing accumulation of evidence of safety and efficiency, and the complete absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology."

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 devoted to the advancement of science and academies of science.

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."



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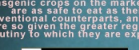
"The ASM is not aware of any acceptable evidence that food products derived from biotechnology and subject to FDA oversight constitutes a health risk. We are sufficiently convinced to assure the safety of GM crops and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life."



The Science Source for Food, Agriculture, and Environmental Issues.

CAST is a nonprofit organization composed of scientific societies and many individual, student, company, nonprofit, and academic scientists.

"Over the last decade, 8.5 million farmers have grown transgenic varieties of crops on more than 1 billion acres of farmland in 17 countries. These crops have been consumed by humans and animals in most countries."



Federation of Animal Science Societies

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

"Meat, milk and eggs from livestock and poultry consuming biotech feeds are safe for human consumption"



Society of Toxicology

The Society of Toxicology is a professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology.

"Scientists agree that the process of GM food production is different nature than those already familiar to consumers. The level of safety of current GM foods to consumers appears to be equivalent to that of traditional foods."



The Union of German Academies of Sciences and Humanities is an umbrella organization for eight German academies of sciences and humanities.

"In consuming food derived from GM plants approved in the EU and in the USA, the risk is in no way higher than in the consumption of food from conventionally grown plants. On the contrary, in some cases food from GM plants appears to be superior in respect to health."

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.



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 detected as a result of the consumption of GM foods by the general population in the countries where they have been approved."



The European Commission (EC) is the executive body of the European Union.

"The main conclusion to be drawn from the efforts of more than 150 research projects during a period of more than 22 years of research and involving more than 100 independent research groups, is that biotechnology, and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."



The American Society for Cell Biology is an international community of biologists dedicated to advancing scientific discovery, advocating sound research policies and improving education.

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Consensus statement on GMO's representing 34 Italian scientific societies.

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- The International Society of African Scientists: "Africa and the Caribbean cannot afford to be left further behind in acquiring the uses and benefits of this new agricultural revolution."
- The Federation of Animal Science Societies stated the following: "Meat, milk and eggs from livestock and poultry consuming biotech feeds are safe for human consumption."

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The ASM represents over 42,000 microbiologists worldwide.

"The ASM is not aware of any acceptable evidence that food produced by biotechnology is unsafe and subject to FDA oversight constitutes a sufficient barrier to assure the safety of the products. We are sufficiently convinced to assure the safety of the products and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life."

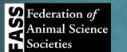


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"Over the last decade, 8.5 million farmers have grown transgenic varieties of crops on more than 1 billion acres of farmland in 17 countries. These crops have been consumed by humans and animals in most countries."

Transgenic crops on the market today are as safe to eat as their conventional counterparts, and likely more so given the greater regulatory scrutiny to which they are exposed.



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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 no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."



England's top medical society, the Royal Society of Medicine is an independent educational organization of doctors, dentists, scientists and others involved in medicine and health.

"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 ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."



American Society of Plant Sciences is a professional society devoted to the advancement of the plant sciences.

"The risks of unintended consequences of the type of gene transfer are comparable to the random mixing of genes during classical breeding. The ASPS believes responsible regulation and oversight, as well as many significant health and environmental benefits to the world and its people."



The Crop Science Society of America is a professional and international scientific society dedicated to the conservation and wise use of natural resources to produce food, feed, and fiber crops while maintaining and improving the environment.

"The Crop Science Society of America supports education and research in all aspects of crop production, including the judicious application of biotechnology."



The SCS is the largest group of crop scientists and biotechnologists in the world among its membership.

"All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product prior to their use by the public."



Prepared by the Royal Society of London, the US National Academy of Sciences, the Chinese Academy of Sciences, the Indian National Science Academy, the Mexican Academy of Sciences and the Thai World Academy of Sciences.

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"No effects on human health have been observed as a result of the consumption of GM foods by the general population in the countries where they have been approved."



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"The main conclusion to be drawn from the efforts of more than 150 research projects during a period of more than 22 years of research and involving more than 100 independent research groups, is that the biotechnological and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."



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• **American Phytopathological Society:**

"The American Phytopathological Society (APS), which represents approximately 5,000 scientists who work with plant pathogens, the diseases they cause, and ways of controlling them, supports biotechnology as a means for improving plant health, food safety, and sustainable growth in plant productivity."



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"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 ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."



The American Chemical Society (ACS) is a professional society devoted to the advancement of the chemical sciences

"The risks of unintended consequences of gene transfer are comparable to the random mixing of genes during classical breeding. The ACS believes responsible regulation and oversight, with full transparency, significant health and environmental benefits to the world and its people."



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The SFB has one of the largest groups of crop geneticists and biotechnologists in the world among its membership

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French Academy of Science:

"This analysis shows that all the criticisms against GMOs can be largely dismissed on strictly scientific criteria."

The Union of the German Academies of Science and Humanities:

"In summary, the evidence suggests it to be most unlikely that the consumption of the well-characterised transgenic DNA from approved GMO food harbours any recognisable health risk."

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“Food derived from GM plants approved in the EU and the US poses no risks greater than those from the corresponding conventional food. On the contrary, in some cases food from GM plants appears to be superior with respect to health.”

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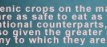
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Die Deutschen Akademien der Wissenschaften

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"In consuming food derived from GM plants approved to the EU and in the USA, the risk is in no way higher than in the consumption of food from conventionally grown plants. On the contrary, in some cases food from GM plants appears to be superior in respect to health."



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 European Commission (EC) is the executive body of the European Union

"The main conclusion to be drawn from the efforts of more than 150 research projects, covering a period of more than 22 years of research, and involving more than 100 independent research groups, is that neither biotechnology, and in particular GMOs, are no more risky than e.g. conventional plant breeding technologies."



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Consensus statement on GMO's, representing 14 Italian scientific societies

"GMOs on the market today, having successfully passed all the tests and procedures necessary for authorization, are to be considered, on the basis of current knowledge, to be safe for use in human and animal foods"



The French academy of science is resolutely committed to the advancement of science and has advised government authorities in those matters and issues deemed within its remit.

"All criticisms against GMOs can be largely rejected on strictly scientific criteria."



International Council for Science

The International Council for Science (ICSU) is an international, non-governmental organization devoted to the advancement of science. Its members are national scientific bodies and international scientific organizations.

"Currently available genetically modified crops – and foods derived from them – have been judged safe to eat, and the methods used to test them have been deemed appropriate"

The American Society for Microbiology:

"The ASM is not aware of any acceptable evidence that food produced with biotechnology and subject to FDA oversight constitutes high risk or is unsafe. We are sufficiently convinced to assure the public that plant varieties and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life."

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 devoted to the advancement of science 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 no adverse consequences on human health have been reported and/or substantiated in the peer-reviewed literature.



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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

"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 ill effects (or legal cases related to human health), despite many of the consumers coming from the most litigious of countries, the USA."



The American Society of Plant Sciences is a professional society devoted to the advancement of the plant sciences.

"The risks of unintended consequences of gene transfer are comparable to the random mixing of alleles during classical breeding. The ASPS believes responsible regulation and oversight, as with all biotechnology, is in the public's best interest and that the environmental benefits to the world and its people."



The Crop Science Society of America (CSSA) is a prominent international scientific society dedicated to the conservation and wise use of natural resources to produce food, feed, and fiber crops while maintaining and improving the environment.

"The Crop Science Society of America supports education and research in all aspects of crop production, including the judicious application of biotechnology."



The SFB has one the largest groups of crop geneticists and biotechnologists in the world among its membership.

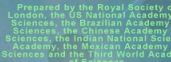
"All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product, prior to their use by the public."



The Federation of Animal Science Societies

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

"Meat, milk and eggs from livestock and poultry consuming biotech feeds are safe for human consumption"



The Society of Toxicology is a professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology.

"Scientific analysis indicates that the process of GM food production is different from that of hazardous, different nature than those already familiar to toxicologists. The safety of current GM foods to consumers appears to be equivalent to that of traditional foods."



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• **The Council for Agricultural Science and Technology:**

"Over the last decade, 8.5 million farmers have grown transgenic varieties of crops on more than 1 billion acres of farmland in 17 countries. These crops have been consumed by humans and animals in most countries. Transgenic crops on the market today are as safe to eat as their conventional counterparts, and likely more so given the greater regulatory scrutiny to which they are exposed."

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"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."



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 \$8 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."



The American Council on Science and Health is a non-profit group of scientists dedicated to ensuring that important public policies related to health and the environment have a sound scientific basis.

"With the continuing accumulation of evidence of safety and efficacy, and the complete absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology."



The ASM represents over 42,000 microbiologists worldwide.

"The ASM is not aware of any acceptable evidence that food produced with biotechnology and subject to FDA oversight constitutes a health risk. We are uniformly and sufficiently convinced to assure the safety of the varieties and products created with biotechnology have the potential of improved nutrition, better taste and longer shelf-life."



The Science Source for Food, Agriculture, and Environmental Issues.

CAST is a nonprofit organization composed of scientific societies and many individual, student, company, nonprofit, and academic scientists.
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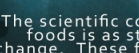
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The SIFC has one the largest groups of crop scientists and biotechnologists in the world among its membership.

"All crop and animal products that result from biotechnology are demonstrated to be safe as non-engineered versions of that plant or animal product, prior to their use by the public."



Prepared by the Royal Society of London, the US National Academy of Sciences, the Chinese Academy of Sciences, the Indian National Science Academy, the Mexican Academy of Sciences and the Japanese Academy of Sciences.

"Foods can be produced through the use of GM technology that are more nutritious, stable in storage, and in principle health promoting—bringing benefits to consumers in both industrialized and developing nations."



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- The American Society of Plant Biologists had this to say:
"The risks of unintended consequences of this type of gene transfer are comparable to the random mixing of genes that occurs during classical breeding. The ASPB believes strongly that, with continued responsible regulation and oversight, GE will bring many significant health and environmental benefits to the world and its people."

Social Diversity



- GE food crop research comes from scientists of varied backgrounds & funding sources

Scientific Literature Not Dominated by Industry-Funded Studies

(Contrary to common Anti-GMO talking points)

- Sanchez, M. A. (2015). Conflict of interests and evidence base for GM crops food/feed safety research. *Nature biotechnology*, 33(2), 135-137.

Table 1 Classification of GM food/feed safety research reports according to their main objective of research, and the percentage of each category reporting COIs.

Research area	Number of reports	Percentage without COIs	Percentage that did not declare funding source	Percentage with COIs
Allergenicity potential	46	71.7%	8.7%	19.6%
Animal health	204	67.2%	16.7%	16.2%
Animal nutrition	111	27.9%	18.9%	53.2%
Equivalence	106	43.4%	13.2%	43.4%
Mycotoxins	18	11.1%	22.2%	66.7%
Processing	18	77.8%	11.1%	11.1%
Traceability and/or digestion (DNA or proteins)	91	69.2%	19.8%	11.0%
Unintended effects	104	77.9%	13.5%	8.7%
Total	698	58.3%	15.9%	25.8%

Outlier Papers Often Cited by GMO Opponents Typically Problematic

- The small fraction of papers claiming harm from GE foods have typically been of lower quality, published in lower end journals, & involved more frequent conflicts of interest (60%) than is found in the general GE food literature (25.8%) (Sánchez et al 2017).
- Sánchez, M. A., & Parrott, W. A. (2017). Characterization of scientific studies usually cited as evidence of adverse effects of GM food/feed. Plant Biotechnology Journal.

“In general terms, all papers analysed here violate at least one of the basic standards for assessment of GM food/feed safety (Bartholomaeus et al., 2013; European Food Safety Authority (EFSA), 2011; ILSI 2008, 2004; Kuiper et al., 2001;”

So Why Do So Many Distrust
GMOs?

I AM BECOME MONSATAN



DESTROYER OF WORLDS

Now, however...

Monsanto has been bought by Bayer...

So, now...

facebook.com/allthesesheep

Monsatan is no more,

**behold the awesome
power of...**

BEEELZEBAYER!

(♪dramatic orchestral music in background♪)

Common Tactics of the Anti-GMO Movement

- Smear Campaigns (FOIA abuse)
- Logical Fallacies (especially the Shill Gambit)
- Fake Experts
- Cherry Picking
- Impossible Expectations & Double Standards
- Sowing Doubt via Speculation & Exaggerating Uncertainties (“scientists were wrong about X!”)
- Conspiracy Theories
- Vandalism

What Do These Two Scientists Have in Common?



Smear Campaigns Against Scientists and Science Communicators



GMO-Gate vs Climate-Gate

ANATOMY OF KEVIN FOLTA

The University of Florida's Monsanto Shill

THE BRAIN

This is where
Monsanto's lies
are stored

THE EYES

This is where the
soul darkens
and evil grows

THE EARS

This is where
audible information is
filtered to remove
scientific facts
and favor GMO lies

THE MOUTH

This is where
Monsanto propaganda
is spewed out



For more GMO news & articles visit
www.GMO.News



Court filings question whether “Professor Mann’s likeness” is protected from parody and satire

The Shill Gambit Fallacy

- Common tactic of anti-vaxxers & GMO opponents
- Involves accusing anyone who disagrees with them of being paid to do so by a big company (i.e. usually “Big Pharma” or “Monsanto”)
- Is a special case of ad hominem & poisoning the well logical fallacies
- Used to deflect from &/or dismiss arguments & evidence against their position

The Shill Gambit

CREDIBLE



\$HILLBUCKS PARADISE

Damn,

it feels
good
to be a

Shillionaire!



Crediblehulk.org [FB.com/TheRealCredibleHulk](https://www.facebook.com/TheRealCredibleHulk)

The Shill Gambit



Common Anti-GMO Arguments



Do GE Crops Increase Pesticide Use?

- The use of GE crops has corresponded to a reduction in total pesticide usage, and a decrease in greenhouse gas emissions attributable to crop farming.
- Brookes, G., & Barfoot, P. (2017). Environmental impacts of genetically modified (GM) crop use 1996–2015: impacts on pesticide use and carbon emissions. *GM crops & food*, 8(2), 117-147.
- Klümper, W., & Qaim, M. (2014). A meta-analysis of the impacts of genetically modified crops. *PloS one*, 9(11), e111629.

GE Crops and CO2

Mitigating carbon emissions

GMOs and CO2



Biotech crops reduce CO2 emissions
by 28 000 million kg a year.

That is equivalent to...



**closing down
7.4 coal-fired
power plants**



or

**removing 12.4 million
cars from the road**

or



**providing 2.5 million
US homes with all
their energy**

Sources: Brookes & Barfoot 2015, *Environmental impacts of genetically modified (gm) crop use 1996-2013: impacts on pesticide use and carbon emissions*
EPA Greenhouse Gas Equivalencies Calculator



Infographic by Thoughtscapism

GE Crops and Pesticides

- Pesticide use decrease mostly due to reduced insecticide use. What about herbicides?

GE Crops and Herbicides:

- Total herbicide usage has increased in BOTH GMO and non-GMO crops.
- However, it has increased *more* with non-GMO crops than with GMO crops. The rate of increase has been greater in non-GMO crops.
- Kniss, A. R. (2017). Long-term trends in the intensity and relative toxicity of herbicide use. *Nature communications*, 8.

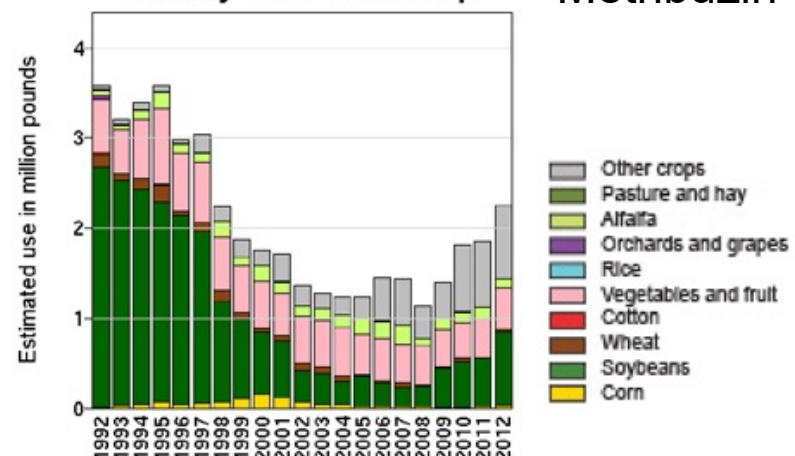
GE Crops and Herbicides:

- Although the rise of glyphosate resistant crops coincided with an increase in glyphosate usage, it also corresponded in the reduction of several other herbicides, nearly all of which were far more toxic than glyphosate.

Use Decreased for Several More Toxic Herbicides

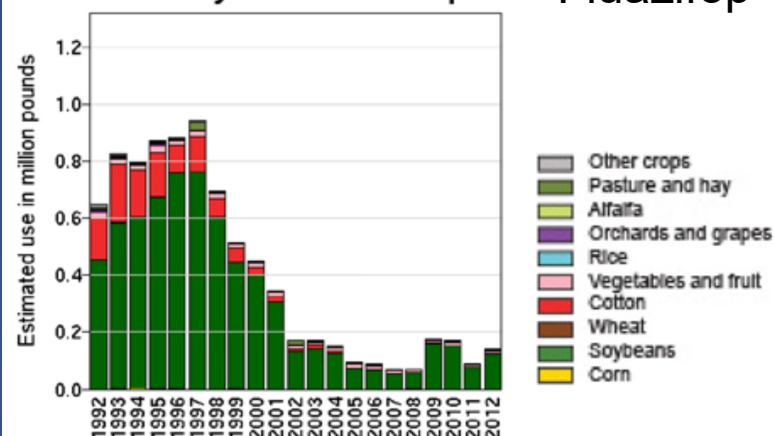
Use by Year and Crop

Metribuzin

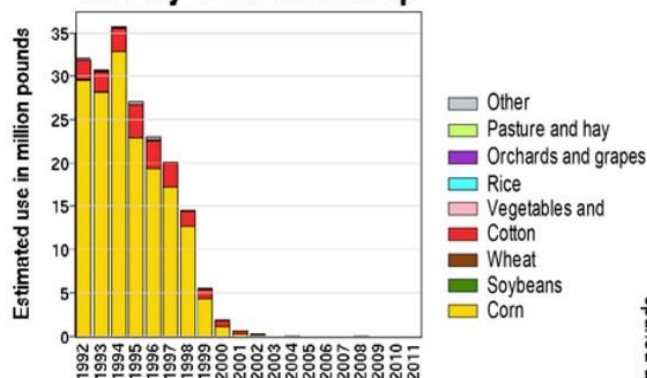


Use by Year and Crop

Fluazifop



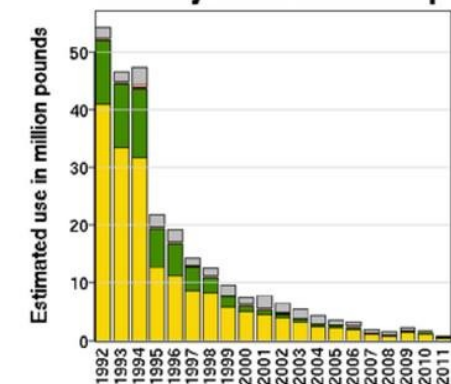
Use by Year and Crop



Cyanazine use 1992 - 2011

Use by Year and Crop

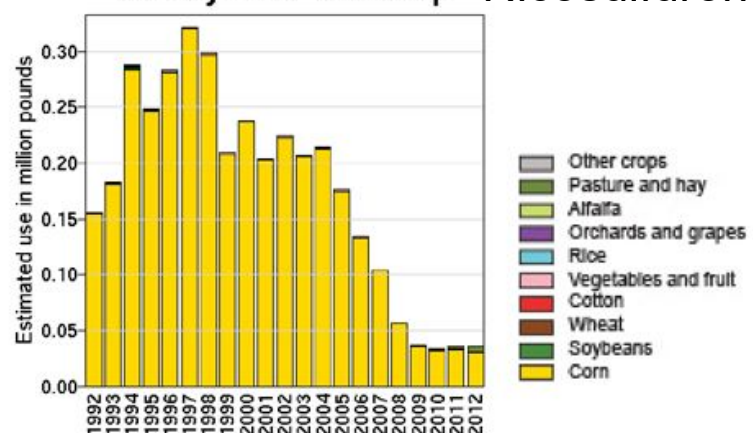
Alachlor



Alachlor use 1992 - 2011

Use by Year and Crop

Nicosulfuron



Non-GE Herbicide Resistant Crops

What is the Difference?



Round-Up Ready Canola

Trait: Herbicide Tolerance

Developed by Monsanto

Modified using transgenesis

Considered a GMO



Clearfield Canola

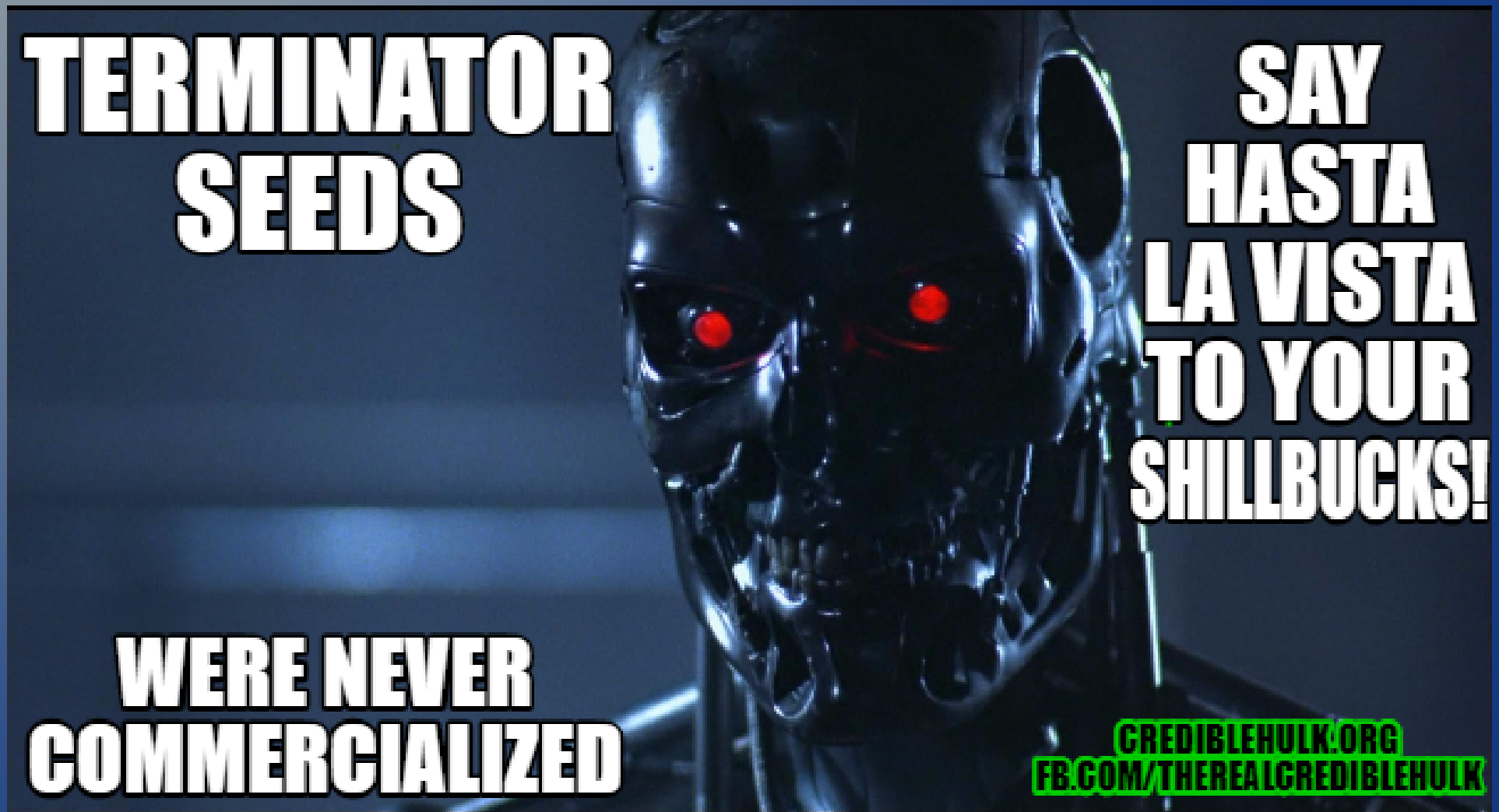
Trait: Herbicide Tolerance

Developed by Pioneer

Modified using mutagenesis

Not considered a GMO

Seed Use Restriction Technology



Terminator Seeds

- Would have made seeds impossible to save and reuse the next season (which licensing agreements would have prohibited anyway)
- Were never brought to market (due largely to complaints by activists)
- Would have prevented accidental cross-contamination

Evolution of Herbicide Resistant Weeds

- Not unique to GE
- More prevalent with herbicides associated with non-GE herbicide resistant crops than with GE
- All forms of weed control have potential for the evolution of resistance: even hand tilling

Some GMOs (such as Bt Crops) Produce Their Own Pesticides

- All cultivated crops do this to some extent
- 99.99% of the pesticides to which humans are exposed through diet are produced endogenously in the plant as part of its evolved defense mechanisms (Ames et al 1990)
- They're no less likely to be toxic or carcinogenic due to being “natural.”
- Neither natural nor synthetic pesticides occur in our food at concentrations high enough to pose significant risk (so don't skip your veggies)

Bt Crops

- *Bacillus thuringiensis* produce proteins toxic to nematodes & several orders of insects
- Bt is used in organic & conventional farming
- Its mode of action requires conditions not present in cells of off-target species
- Bt GMO crops have this trait engineered directly into their genome
- Their implementation has corresponded to a reduction in exogenous insecticide use

GE Crops & Biodiversity

- This is a general farming issue: not a GE issue
- Measures include genetic diversity, species richness, & various quantitative means combining species richness & relative abundances
- Inserting transgenes into diverse germplasm is trivial, so biotech traits are a non-issue insofar as genetic diversity
- When replacement varieties are accounted for, species richness of crop seeds has only decreased by 2% since 1903

Concluding Summary

- GE is an important tool in our arsenal
- Approved GE crops are as safe as non-GE, & the process poses no discernible unique risks
- Widespread public mistrust persists despite a robust international scientific consensus
- Anti-GE arguments are invariably either fallacious, inaccurate &/or not unique to GE
- GE has helped decrease insecticide use, encouraged use of milder herbicides, & can potentially help combat many other challenges