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Genetically Engineered Crops: Experiences and Prospects

May 17, 2016 Report Release Event



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Motivation for Study

 Claims and research that extol either the benefits of or the risks posed by current genetically engineered (GE) crops and food have created a confusing landscape for the public and policy-makers.

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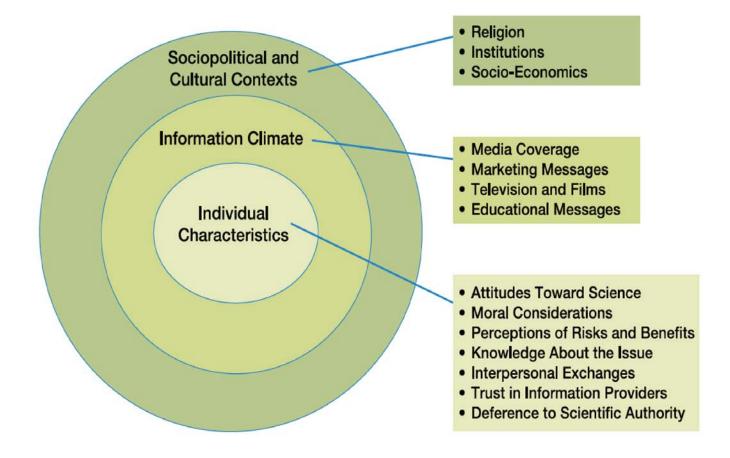
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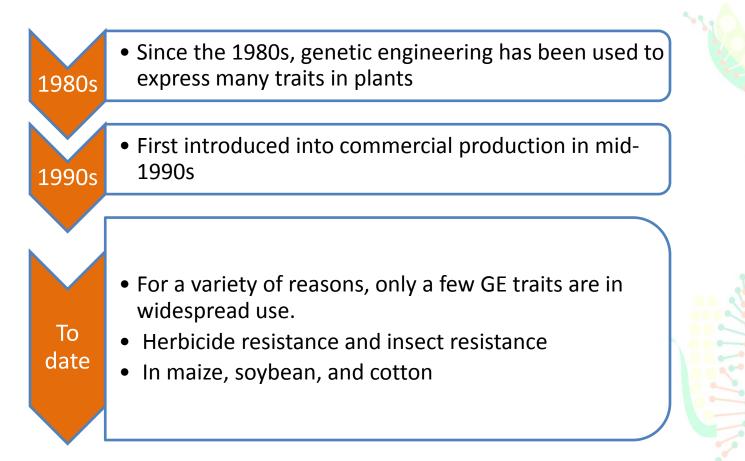
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- A clear need for a study that carefully examined the evidence behind these claims and the rigor of the research.
- Because the GE technologies are changing so rapidly, there was a need for a study examining the cutting edge, and where that may take us in the future.

Contextual filters that influence a person's perception of scientific innovations

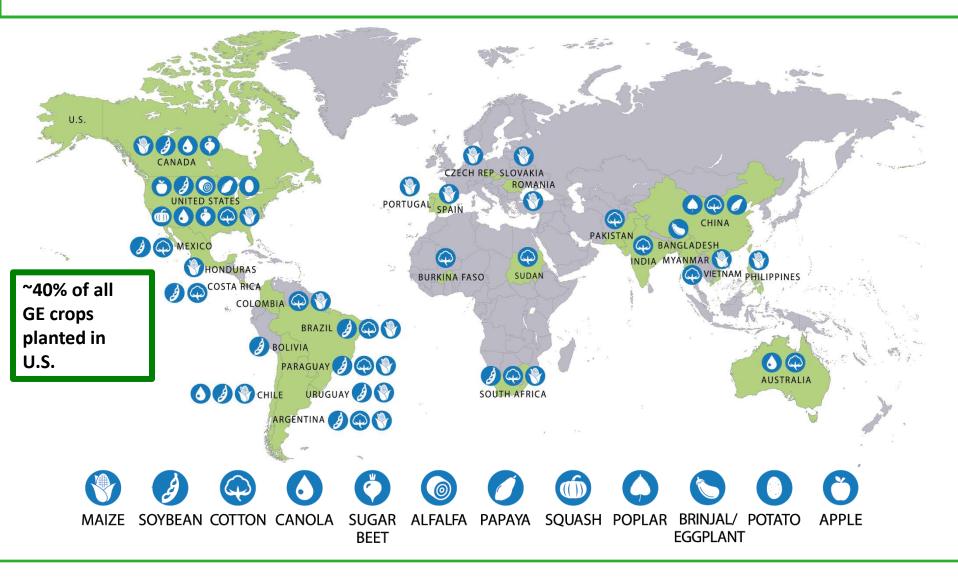


20+ Years of Experience with Genetically Engineered Crops



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GE Crops Planted on 12% of World's Cropland



Committee on Genetically Engineered Crops

ENTOMOLOGY

FRED GOULD (CHAIR), North Carolina State University

MOLECULAR BIOLOGY AND GENOMICS

RICHARD M. AMASINO, University of Wisconsin–Madison

C. ROBIN BUELL, Michigan State University

CROP BIOTECHNOLOGY

RICHARD A. DIXON, University of North Texas

C. NEAL STEWART, University of Tennessee

RISK COMMUNICATION DOMINIQUE BROSSARD, University of Wisconsin–Madison

ECONOMICS

JOSÉ B. FALCK-ZEPEDA, International Food Policy Research Institute (IFPRI)

TOXICOLOGY

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FOOD SCIENCE

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ECOLOGY

KEN GILLER, Wageningen University PETER M. KAREIVA, University of California–Los Angeles

WEED SCIENCE

CAROL MALLORY-SMITH, Oregon State University

PLANT BREEDING

KEVIN PIXLEY, International Maize and Wheat Improvement Center (CIMMYT) **DAVID M. STELLY**, Texas A&M University and Texas A&M AgriLife Research

SOCIOLOGY

LELAND GLENNA, Pennsylvania State University

ELIZABETH P. RANSOM, University of Richmond

LAW

MICHAEL RODEMEYER, University of Virginia (formerly)

DANIEL MAGRAW, Johns Hopkins University School of Advanced International Studies

FOOD SAFETY

ROBERT J. WHITAKER, Produce Marketing Association

AGRONOMY

TIMOTHY S. GRIFFIN, Tufts University

This study was supported by the Burroughs Wellcome Fund, the Gordon and Betty Moore Foundation, the New Venture Fund, the U.S. Department of Agriculture, and the National Academy of Sciences.

Committee's Process

- 1996 National Research Council report, Understanding Risk: Informing Decisions in a Democratic Society. A purely technical assessment of risk could result in an analysis that accurately answered the wrong questions and will be of little use to decision makers.
- Academy study process. "Efforts are made to solicit input from individuals who have been directly involved in, or who have special knowledge of, the problem under consideration."
- Academy study process. "Report should show that the committee has considered all credible views on the topics it addresses."

Committee's Process

- Examined the relevant literature (1000+ research and other publications)
- Held information-gathering meetings
 80 presentations (archived)
- Read more than 700 comments submitted by members of the public

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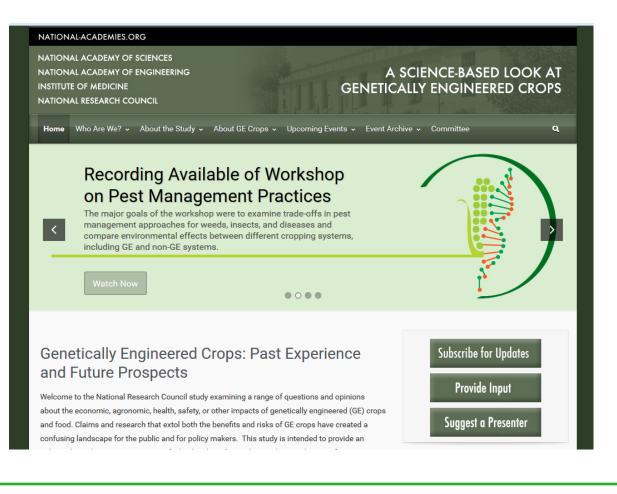
the introduction of GE crops, based on current evidence. The study is being conducted by

A SCIENCE-BASED LOOK AT GENETICALLY ENGINEERED CROPS

Home Who Are We? 、 About the Study 、 About GE Crops 、 Event Archive 、 Commit	tee Public Release Event Q
Public Meetings	
Report Release Event Dat Webinars	Socioeconomic Issues in
Announced!	Developing Countries
The Genetically Engineered Crops: Experiences and Prospects report	RNAi Technology
will be released on Tuesday, May 17 at 11:00 am Eastern! This event	Intellectual Property Issues
is open to registered attendees in person and remotely via live webcast.	Donor Organizations
webcast.	GE Quality Traits
	Microbiome
Register Here Speakers covered	GE Trees
wide range of topics	Socioeconomic Issues
	Safety of GE Foods, an NRC
	Report
Genetically Engineered Crops: Past Experience	Social Science Research
and Future Prospects	Plant Breeding <u>lic Issues</u>
Welcome to the National Academies of Sciences, Engineering, and Medicine study examining a	GE Disease Resistance
range of questions and opinions about the economic, agronomic, health, safety, or other impacts of	US Agricultural Extension the full list here.
genetically engineered (GE) crops and food. Claims and research that extol both the benefits and	International Trade
risks of GE crops have created a confusing landscape for the public and for policy makers. This	US Agricultural Extension
study is intended to provide an independent, objective examination of what has been learned since	subscribe for Updates

Broad Communications Throughout Study

- 1800 subscribers
- 1200 Twitter followers
- 2-min Statement of Task video; meet the members videos
- Topical understandable products



A Key Message: No Longer Clear Distinction Between Crop-Improvement Approaches

- New technologies in genetic engineering and conventional breeding are blurring the distinction between the two approaches (e.g., Gene editing and TILLING)
- It is not possible to make sweeping generalizations about the benefits and risks of GE crops
- All technologies for improving plant genetics have the potential to change foods in ways that raise safety issues

Committee's Analysis of Current GE Crops

- Based on experience to date
 - Mostly restricted to herbicide-resistant and insectresistant varieties of maize, cotton, and soybean
 - Data from industrial-scale and low-resource farms
- Analysis conducted for:
 - Agronomic and environmental effects
 - Human health effects
 - Social and economic effects

• Reduction in yield losses from insect pests.

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- Often higher insect biodiversity than in plantings of similar varieties without the *Bt* trait but with synthetic insecticides.
- Where resistance-management strategies were not followed, damaging levels of resistance evolved in some target insects.

• Herbicide-resistant crops sometimes contribute to higher yield but mostly increase flexibility in farm operations.

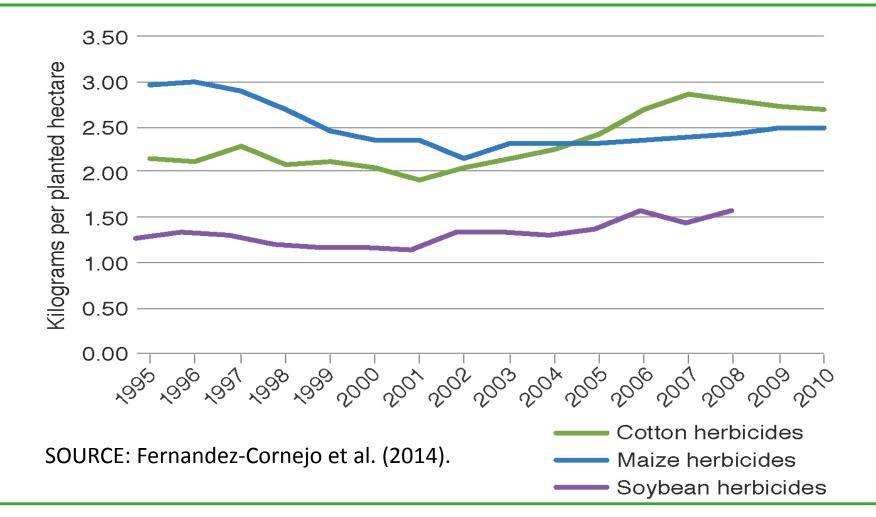
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- Weeds have evolved resistance to glyphosate.
- Integrated weed-management approaches should be used to delay resistance. (This is true for GE and non-GE crops.)

Herbicide use in cotton, maize, and soybean in the United States, 1995–2010



Experiences: Agronomic and Environmental Effects

General Findings:

 Although gene flow has occurred, no examples have demonstrated an adverse environmental effect of gene flow from a GE crop to a wild, related plant species.

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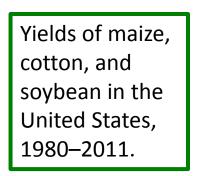
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- No conclusive evidence of cause-and-effect relationships between GE crops and environmental problems.

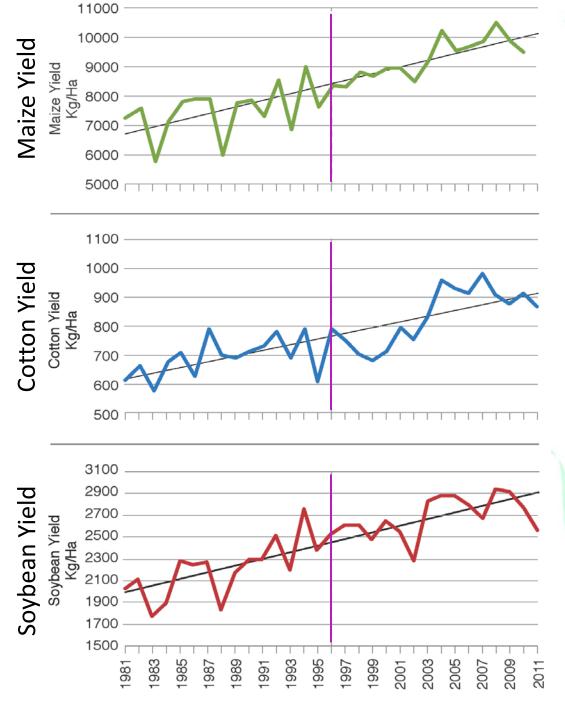
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- Although gene flow has occurred, no examples have demonstrated an adverse environmental effect of gene flow from a GE crop to a wild, related plant species.
- No conclusive evidence of cause-and-effect relationships between GE crops and environmental problems.
- No evidence from USDA data that genetic engineering has increased the rate at which U.S. crop yields are increasing.





USDA Data SOURCE: Duke (2015)

Experiences: Human Health Effects

The committee re-examined most of the original studies:

- Studies conducted with animals. (Not optimally designed)
- Long-term data on the health and feed-conversion efficiency of livestock.
- Comparative data on nutrient and chemical composition.
- Epidemiological data of specific health problems for populations in the United States and Canada compared to United Kingdom and western Europe.

Experiences: Human Health Effects

CONCLUSION: No persuasive evidence of adverse health effects directly attributable to consumption of foods derived from GE crops.

CAVEAT: With any new food, GE or non-GE, there may always be some subtle *favorable or adverse health effects* that are not detected even with careful scrutiny, and health effects can develop over time.

Experiences: Social and Economic Effects

CONCLUSION: Available evidence generally indicates favorable economic outcomes for producers of GE maize, cotton, and soybean, although there is high heterogeneity.

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Experiences: Social and Economic Effects

CONCLUSION: Available evidence generally indicates favorable economic outcomes for producers of GE maize, cotton, and soybean, although there is high heterogeneity.

CAVEAT: Although GE crops have provided economic benefits to many small-scale farmers in the **early years of adoption**, enduring and widespread gains will depend on institutional support and access to profitable local and global markets.

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Experiences: Social and Economic Effects

CONCLUSION: Benefits to intended stakeholders depend on the social and economic contexts in which technology is developed and diffused.

- Regulations need to balance biosafety and consumer confidence with impacts on innovation and deployment of beneficial products.
- **Patents** may limit access for farmers and plant breeders who lack resources.
- GE crops alone are not able to address the complex challenges to productivity on small-scale farms in food insecure places.

Prospects for Novel Genetically Engineered Crops

CONCLUSION: Emerging genetic-engineering technologies^{*} are expected to increase the precision, complexity, and diversity in GE crop development.

- **Resistance traits** for a broader array of insect pests and diseases in more crops are likely.
- **High uncertainty** about other new traits, such as increased efficiency in photosynthesis and nitrogen use.
- Balanced public investment in diverse GE and non-GE approaches is recommended to address food security.

Prospects for Evaluation of Crops with Novel Characteristics

- Omics technologies can provide a "fingerprint" of a plant's composition.
- These technologies can examine new GE and non-GE crops for intended and unintended effects.
- Further development of -omics is needed.

Diverse Regulatory Approaches

- Regulatory processes for products of genetic engineering differ among countries because they mirror the broader social, political, legal, and cultural differences.
- All issues cannot be answered by technical assessments alone.
- Disagreements among countries about regulatory models and resulting trade disagreements are expected to continue as part of the international landscape.

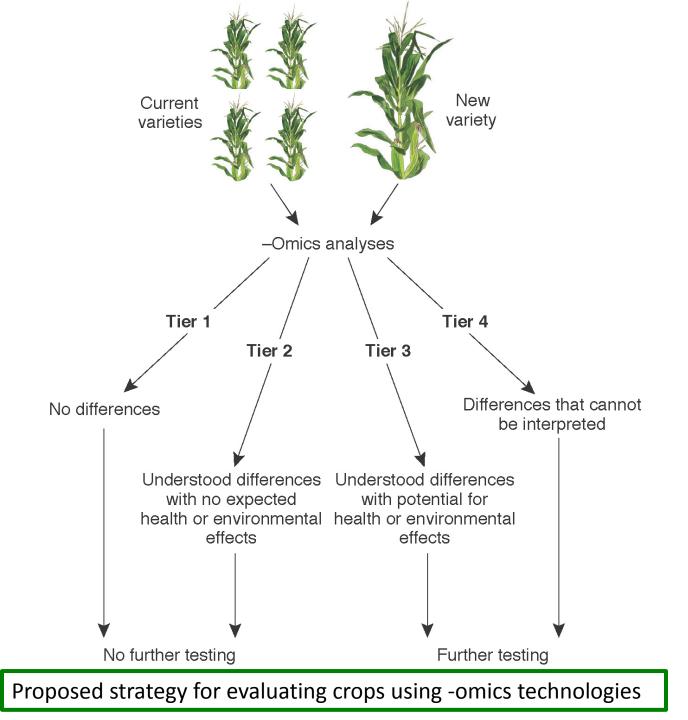
Regulation Should Be Based on Novelty

 In determining whether a new plant variety should be subject to safety testing, regulators should focus on:

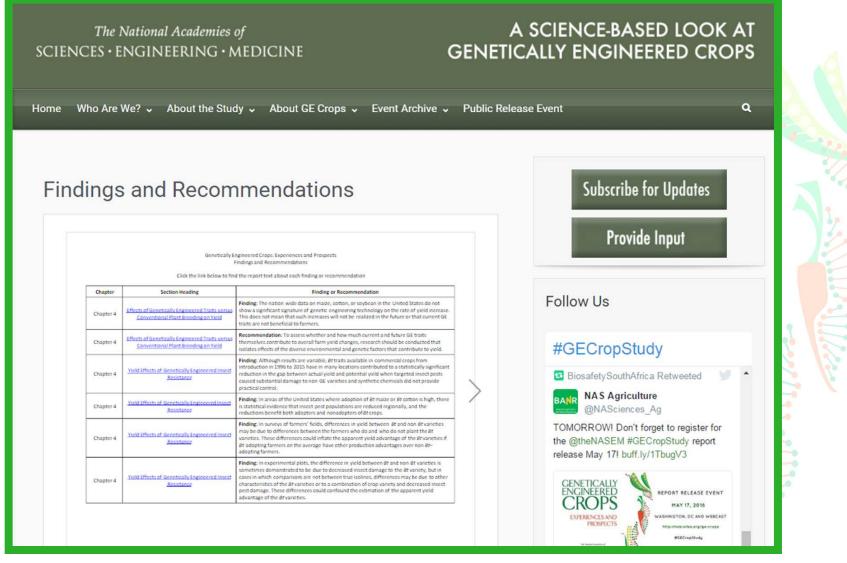
novel characteristics

➤uncertainty about risk

-Omics technologies will be critical in enabling these regulatory approaches



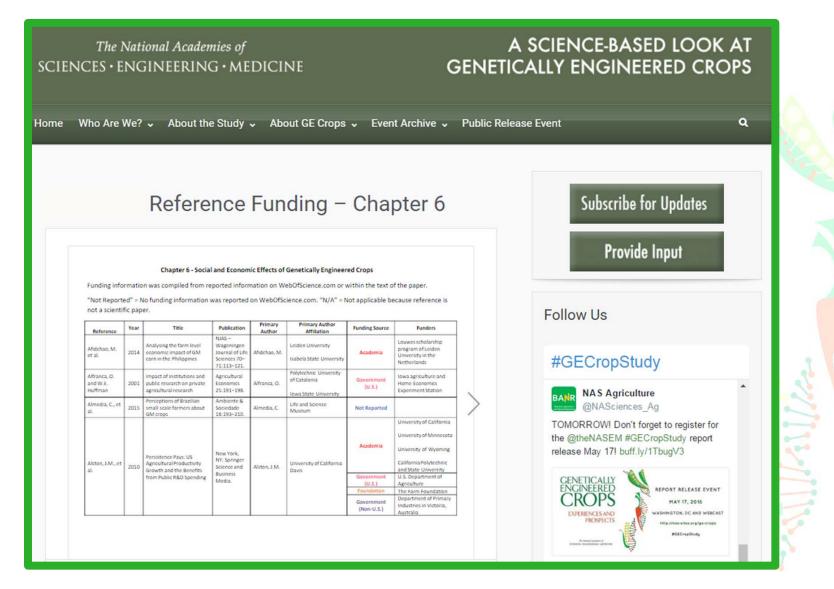
Interfaces with the Reader



Interfaces with the Reader

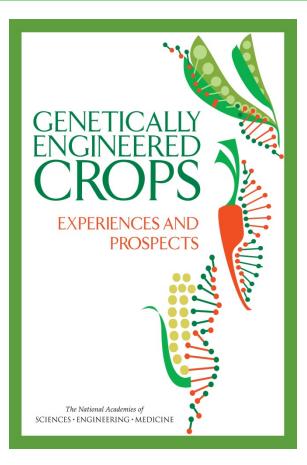


Interfaces with the Reader



Only able to identify funding for 55.3% of studies

Acknowledgments



Academies Staff Sponsors Committee **Reviewers Speakers** Members of the public who took the time to provide comment

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Visit nas-sites.org/ge-crops to find

- The report for free PDF download
- Report in Brief (4-page lay summary)
- Briefing slides and archived public release webcast

Join the conversation: #GECropStudy

Questions? Contact gecrops@nas.edu