

# Biotechnology and Biodiversity



“La Biotecnología Moderna y sus Impactos en la Agricultura”  
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## Can GMOs HELP PROTECT THE ENVIRONMENT?



**THEY ALREADY DO.**

Contrary to myths about GMOs hurting the environment, GMOs allow farmers to preserve the land while doing more with less resources

### The Environmental CHALLENGE:

**20% INCREASE BY 2050<sup>1</sup>**

**HIGHER DEMAND FOR**



**2 POTENTIAL PATHS**

- 1 Convert more land, like forests and prairies, into agricultural production
- 2 Use agricultural technologies like GMOs to increase crop yields on existing farmland

### GMOs are ONE SOLUTION

In 2014, GMOs allowed farmers to use

**51 MILLION** less acres of land



to produce the same amount of food, fuel and fiber crops

Without access to GMOs, farmers would have needed to plant an additional:



to keep up with global production levels in 2014<sup>3</sup>

<sup>1</sup>World population projected to reach 9.7 billion by 2050 (2015). Retrieved from: <http://www.un.org/en/development/desa/news/population/2015-report.html>  
<sup>2</sup>Brookes, G. and Barfoot, P. (2016). GM crops global socio-economic and environmental impacts 1996-2014. Retrieved from <http://www.pegconomics.co.uk>  
<sup>3</sup>Brookes, G. and Barfoot, P. (2016). GM crops global socio-economic and environmental impacts 1996-2014. Retrieved from <http://www.pegconomics.co.uk>



# Genetically Modified Organism

n. A plant or meat product that has had its DNA artificially altered at the molecular level in a lab, usually by genes from other plants, animals, viruses or bacteria. *Not found in nature and cannot occur naturally.*

### Something to Ponder...

#### People:

- No long-term human testing
- No labels = no traceability of harmful effects = no liability

#### Animals:

- Infertility
  - Immune system suppression
  - Accelerated aging
  - Severe allergic reactions
  - Altered genes
- Alterations in liver, kidney, spleen and gut function



### GM Soy + Rat Study, 2005: Dangerous to Babies



### Farms/Food Supply:

- Increased pesticide use
- Destroys sustainable agriculture (cross-pollination)
- Creates super-weeds + new strains of resistant bacteria
- Monocultures more susceptible to disease/pests + wipeout (ex., from 50,000 corn varieties to a few)
- Terminator gene recently patented
- Decreases trade for US farmers (foreign non-GMO markets won't accept GMO food)
- Playing with fire: Once GMO strains are in our ecosystem, there are no "take-backs."

### 50 Countries Label/Ban GMOs



### GMOs in the US, 2011

Percentage of each crop grown GMO vs. Non-GMO



**High-Risk Foods** (so far)

Crops:	Animal products*
• Alfalfa	• Milk
• Canola	• Meat
• Corn	• Eggs
• Cotton	• Honey
• Papaya	
• Soy	
• Sugar Beets	
• Zucchini/ Yellow Squash	

\*via GMO contaminated feed

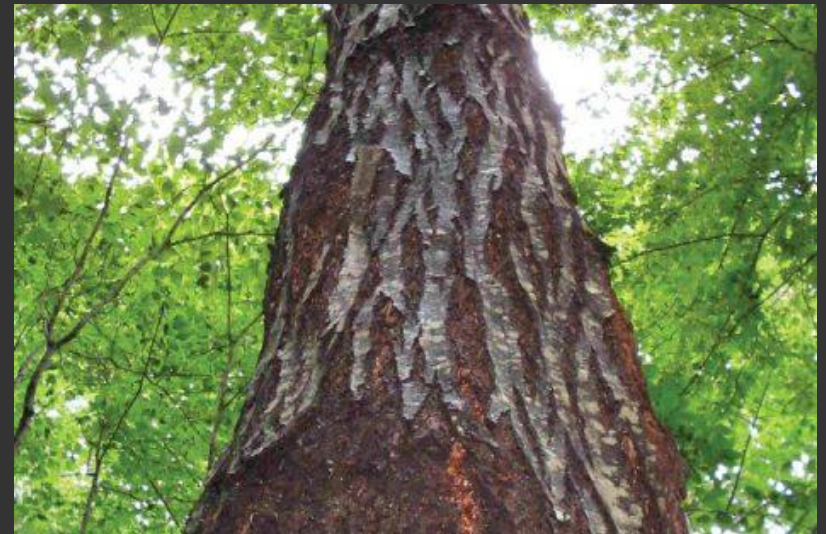
In US, NONE of them are LABELED.

**Organic certification does not require GMO testing.**

# GE Crops



# GE Chestnut

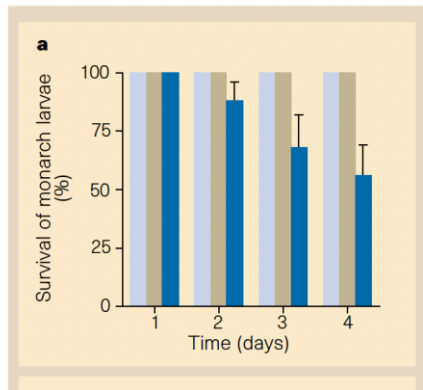


# GE Crops and Biodiversity

## scientific correspondence

### Transgenic pollen harms monarch larvae

Although plants transformed with genetic material from the bacterium *Bacillus thuringiensis* (*Bt*) are generally thought to have negligible impact on non-target organisms<sup>1</sup>, *Bt* corn plants might represent a risk because most hybrids express the *Bt* toxin in pollen<sup>2</sup>, and corn pollen is dispersed over at least 60 metres by wind<sup>3</sup>.

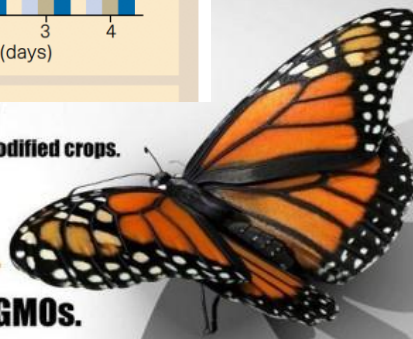


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**The problem:**  
Genetically modified crops.

**Save  
Our  
Monarchs.**

**Boycott GMOs.**



NATURE | VOL 399 | 20 MAY 1999 | www.nature.com

### THREE YEARS LATER:

## Genetically Engineered Corn and the Monarch Butterfly Controversy

# MONSANTO ROUNDS UP MONARCH BUTTERFLY

WIDESPREAD USE OF ROUNDUP IS RESPONSIBLE FOR KILLING VAST AMOUNTS OF MILKWEED - MONARCH BUTTERFLY BREEDING GROUND. IT'S USE HAS CAUSED A 28% DECLINE IN MONARCH BUTTERFLY POPULATIONS SINCE LAST YEAR AND AN 85% DECLINE IN POPULATIONS SINCE 1996 - THE SAME YEAR MONSANTO INTRODUCED THEIR "ROUNDUP READY" GMO SEEDS.

### Download the Genetically Engineered Crops Report for Free!

The Genetically Engineered Crops: Experiences and Prospects report and supplemental documents can be downloaded for free!



[Read The Report Here](#)



Chair:  
Dr. Fred  
Gould

# GENETICALLY ENGINEERED CROPS

EXPERIENCES AND  
PROSPECTS



## Genetically Engineered Crops: Experiences and Prospects

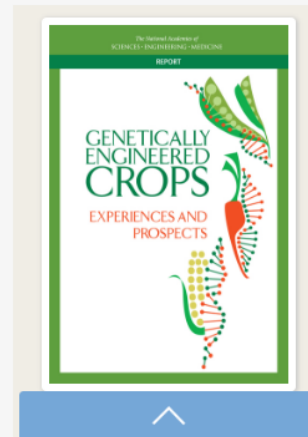
Welcome to the National Academies of Sciences, Engineering, and Medicine study examining a range of questions and opinions about the economic, agronomic, health, safety, or other impacts of genetically engineered (GE) crops and food. Claims and research that extol both the benefits and risks of GE crops have created a confusing landscape for the public and for policy makers. This study is intended to provide an independent, objective examination of what has been learned since the introduction of GE crops, based on current evidence.

### Forum of Scientific Society Leaders on Genetically Engineered Crops: Experiences and Prospects

Representatives of 15 scientific societies met to explore the findings, conclusions, and recommendations of the report.

[View Videos Here](#)

Download the Report Here



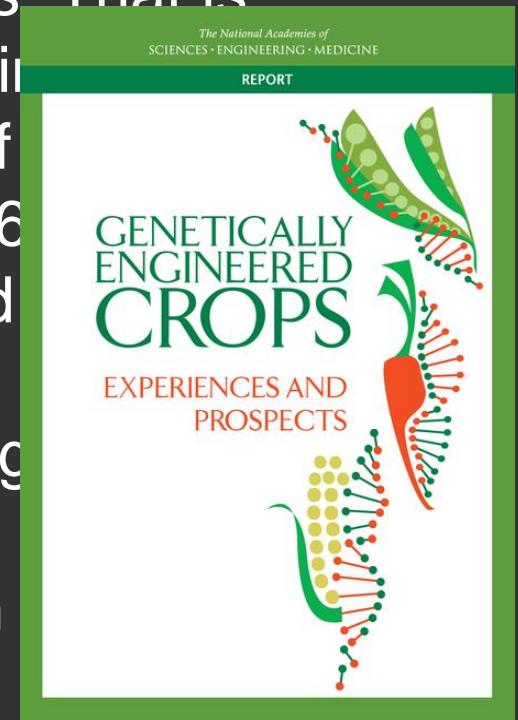
# Agricultural Biotechnology – Bt Crops

- Reduced application of synthetic insecticides (positive spillover effects)
- Decreased yield losses (but farmer differences may inflate differences)
- Higher insect biodiversity than farms treated with synthetic insecticides
- Emergence of resistance in target insects where resistance-management strategies not followed: high dose/refuge strategy (NASEM, 2016)

# Agricultural Biotechnology – Herbicide Resistant Crops

- Small yield increases (but no evidence of change in rate of increase in U.S.)
- Decreased herbicide application initially, but not sustained (but comparisons are faulty because hazards vary)
- No evidence of lower plant diversity in U.S. fields
- Weeds develop resistance with heavy reliance on glyphosate (NASEM, 2016)

**“Overall, the committee found no conclusive evidence of cause-and-effect relationships between GE crops and environmental problems.** However, the complex nature of assessing long-term environmental changes often made it difficult to reach definitive conclusions. That is illustrated by the case of the decline in overwintering monarch butterfly populations. Studies and analyses of monarch dynamics reported as of March 2016 have not shown that suppression of milkweed by glyphosate is the cause of monarch decline. However, there is as yet no consensus among researchers that increased glyphosate use is not at all associated with decreased monarch populations” (NASEM, 2016: 15)





# Biotechnology FOR Conservation - GMO 2.0?

The National Academies of

SCIENCES  
ENGINEERING  
MEDICINE

THE POTENTIAL FOR BIOTECHNOLOGY TO ADDRESS FOREST HEALTH



International Union for the Conservation of Nature



Synthetic Biology

and Biodiversity Conservation Task Force





Source: American Chestnut Foundation



Source: National Geographic



Source: [www.masschestnut.org](http://www.masschestnut.org)

# Restoring the American Chestnut

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[ESF HOME](#) > [CHESTNUT](#)

## The American Chestnut Research & Restoration Project at ESF

### A Forest Reborn

The ESF American Chestnut Project has developed a blight-tolerant American chestnut tree, and is working to restore this iconic and valuable cultural symbol to the forest ecosystems of the eastern United States.

- [The Chestnut Project in a 'Nutshell'](#) (video)

### A Growing Effort

- [We nearly killed off these trees. But biotech can bring them back.](#) ([Washington Post](#), 5/18)

Learn more about how a solution developed by ESF researchers is leading the way in returning the American chestnut to our forests.

- [About the project](#)
- [The history of the American chestnut blight and restoration efforts](#)
- [Project research](#)
- [The American Chestnut Foundation](#)

### Join Us!

We have started growing 10,000 blight-resistant American chestnut trees to restore the tree to its native range. **Help us meet the challenge!**

[Support the Chestnut Fund](#)

- [Learn more about joining the effort!](#)





Very small stem blight resistance assay showing significant blight resistance enhancement using the OxO gene.



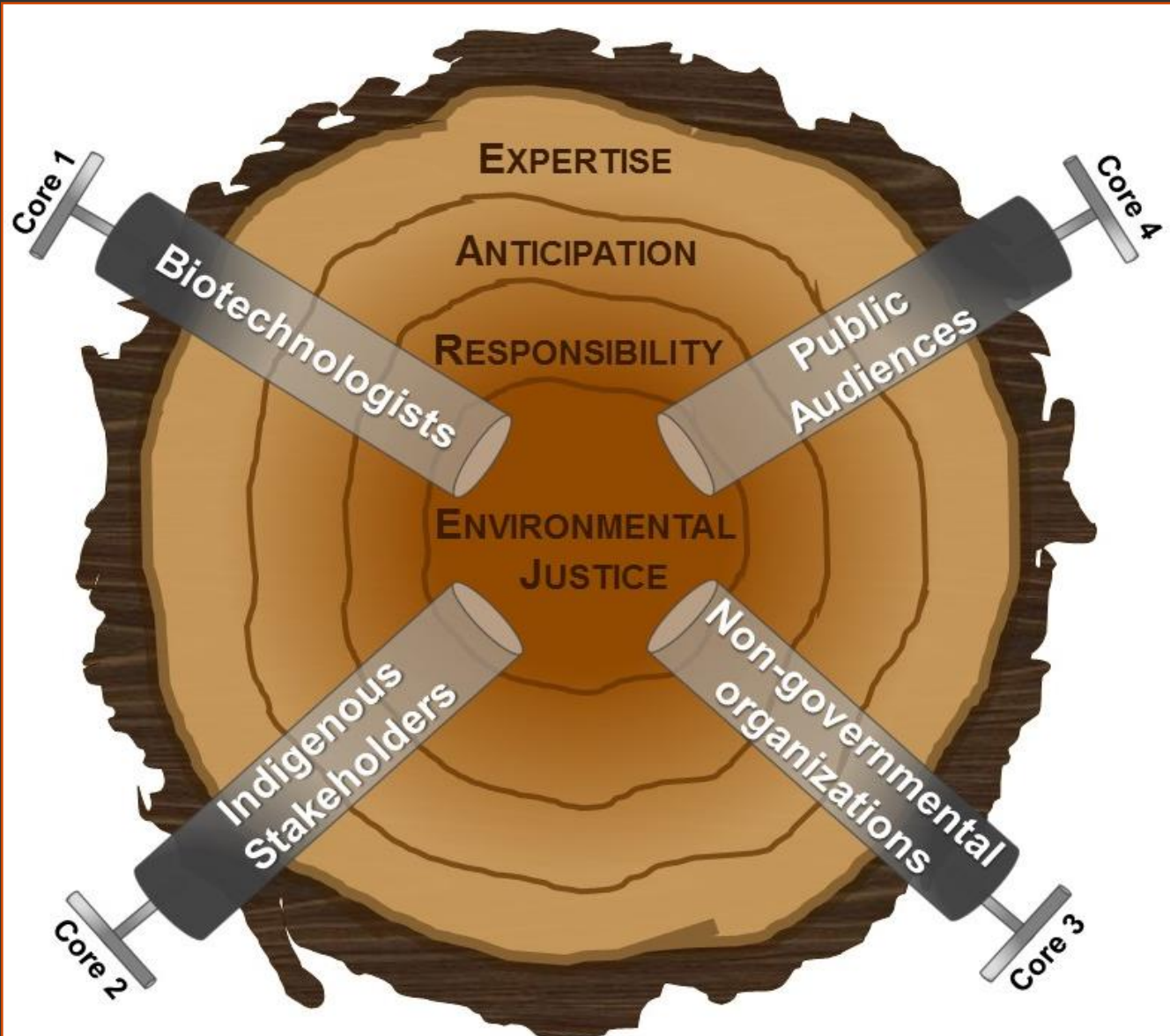
Darling 215 and Darling 311, OxO transgenic American chestnut



Chinese chestnut  
control  
(Qing)

American chestnut  
control  
(Ellis1)

All plants were produced from tissue culture. Non-transgenic & transgenic Americans are clonal (Ellis 1 cell line). Pictured 8 days post inoculation with *C.parasitica* strain EP155. American stem diameters were ~1.5mm, Chinese ~2.0mm. Darling 215 OxO expression level is the threshold for high resistance in leaf assays and Darling 311 has higher expression levels than 215.



“Responsible Innovation with Genetically Modified American Chestnut Trees”



Grant No. 1632670  
Science, Technology, and Society Program

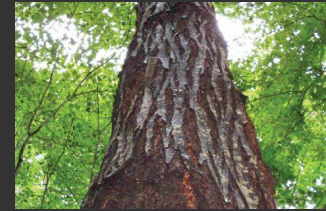
# GE American Chestnut - Promises

- Restoration of functionally extinct species
- Mast crop (chestnuts) to support wildlife
- No negative impacts on tadpoles, beneficial fungi, or bumblebees (e.g., D'Amico, *et al.* 2015)
- Deployment strategy to protect genetic diversity of American chestnut trees
- No patents sought by inventors - partnership with American Chestnut Foundation (NGO)

# GE American Chestnut - Questions

- Regulation – First GMO designed to spread and persist in environment? Field trials?
- Backcross breeding and cisgenic options?
- Incomplete solution – phytophthora (root rot), climate change?
- Sovereignty – indigenous territories and Canadian border?
- “Trojan Horse” – Paving the way for transgenic trees for plantation forestry?

# Biotechnology & Biodiversity



- Biodiversity impacts are complex, difficult to measure and predict, and not uniform (despite strong claims by proponents and opponents).
- Not simply a matter of "getting the science right" (politics, ethics, public preferences).
- Value of diverse forms and sources of expertise.
- Need for community, stakeholder, and public engagement (NASEM, 2016b).



<https://research.ncsu.edu/ges/>

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**Integrating scientific knowledge & public values in shaping the futures of biotechnology**

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