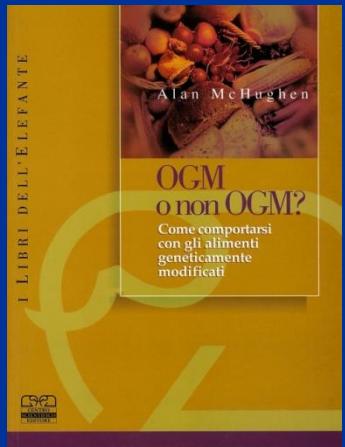
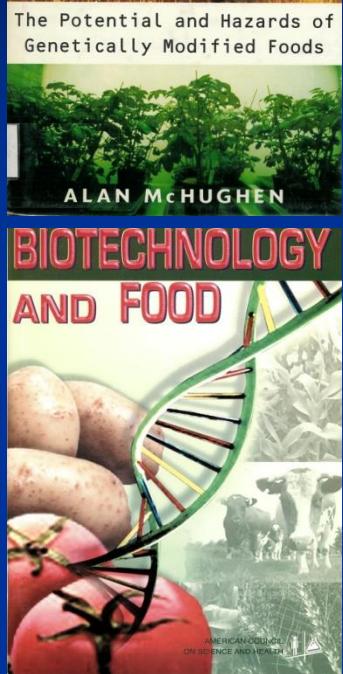


PANDORA'S PICNIC BASKET



GMOs

What Does the Science Say?

Alan McHughen

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Riverside, Ca. 92521

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a consumer's
guide to
GM food
from green genes
to red herrings

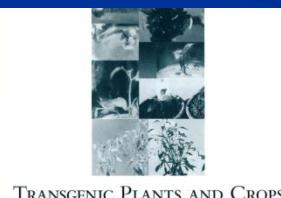


Alan McHughen

Chris A. Wozniak
Alan McHughen Editors

Regulation of
Agricultural
Biotechnology:
The United States
and Canada

Springer

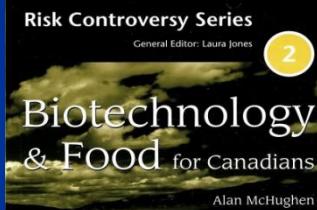


TRANSGENIC PLANTS AND CROPS

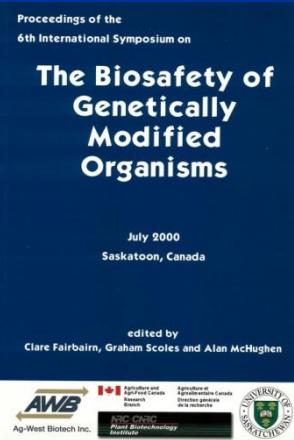
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Alan McHughen



AWB
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Agriculture and
Agri-Food Research
Institute
Agriculture and
Agri-Food Canada
Directors general
and Presidents
University of Saskatchewan

2

Some GE Products

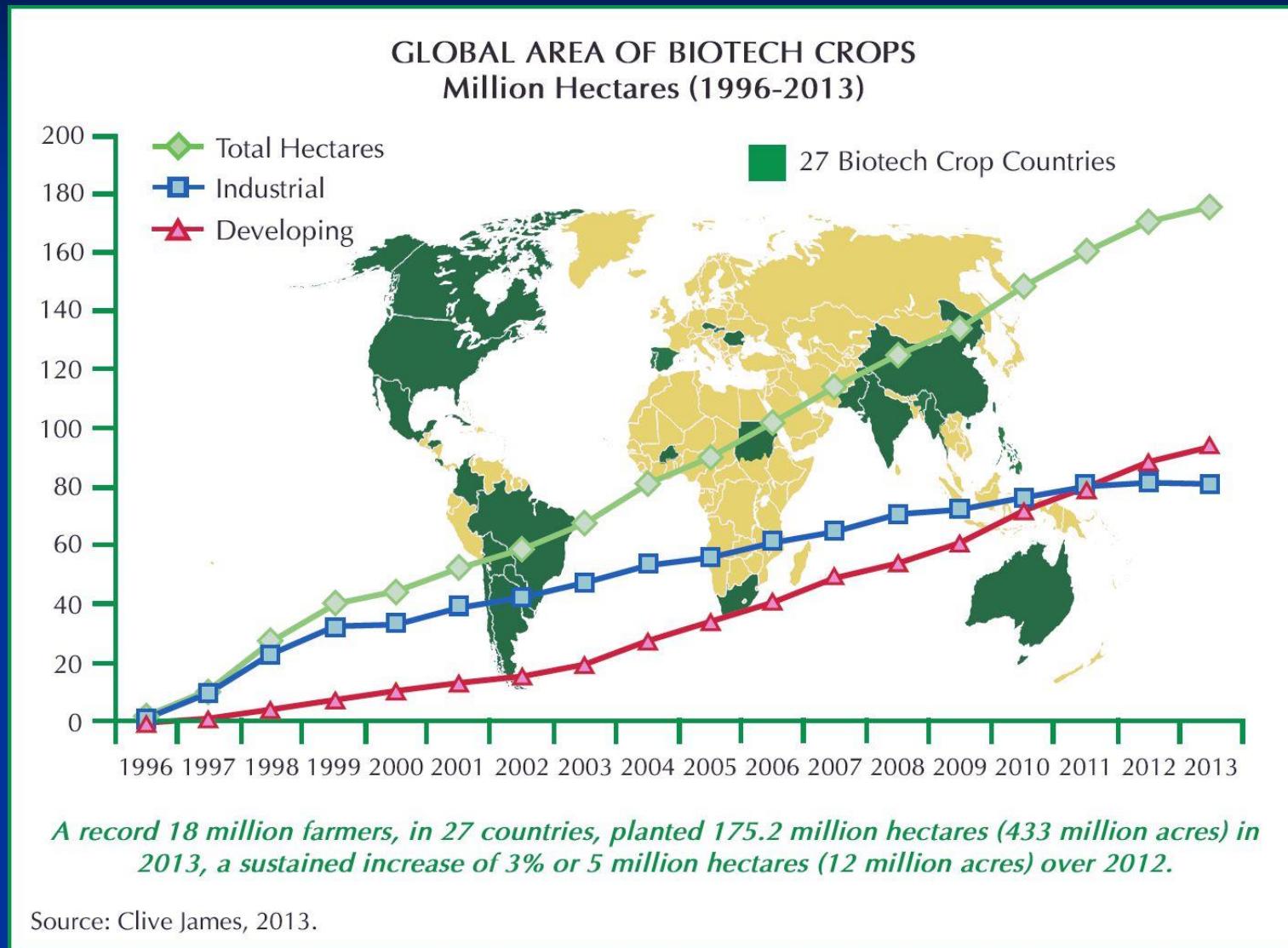
- Human insulin (since 1978, FDA 1982)
- Chymosin (since 1986, FDA 1990)
- Flavr-Savr™ Tomato (FDA 1994- 1997)
- Virus resistant Squash (FDA 1995)
- Virus resistant Papaya (1991, USDA-1998)
- Others (mostly purified, no GE ingredients in food): corn, soy, canola, cotton, alfalfa, sugar beet
- *Also:* A multitude of GE drugs, vitamins, additives.

Status of GE crops

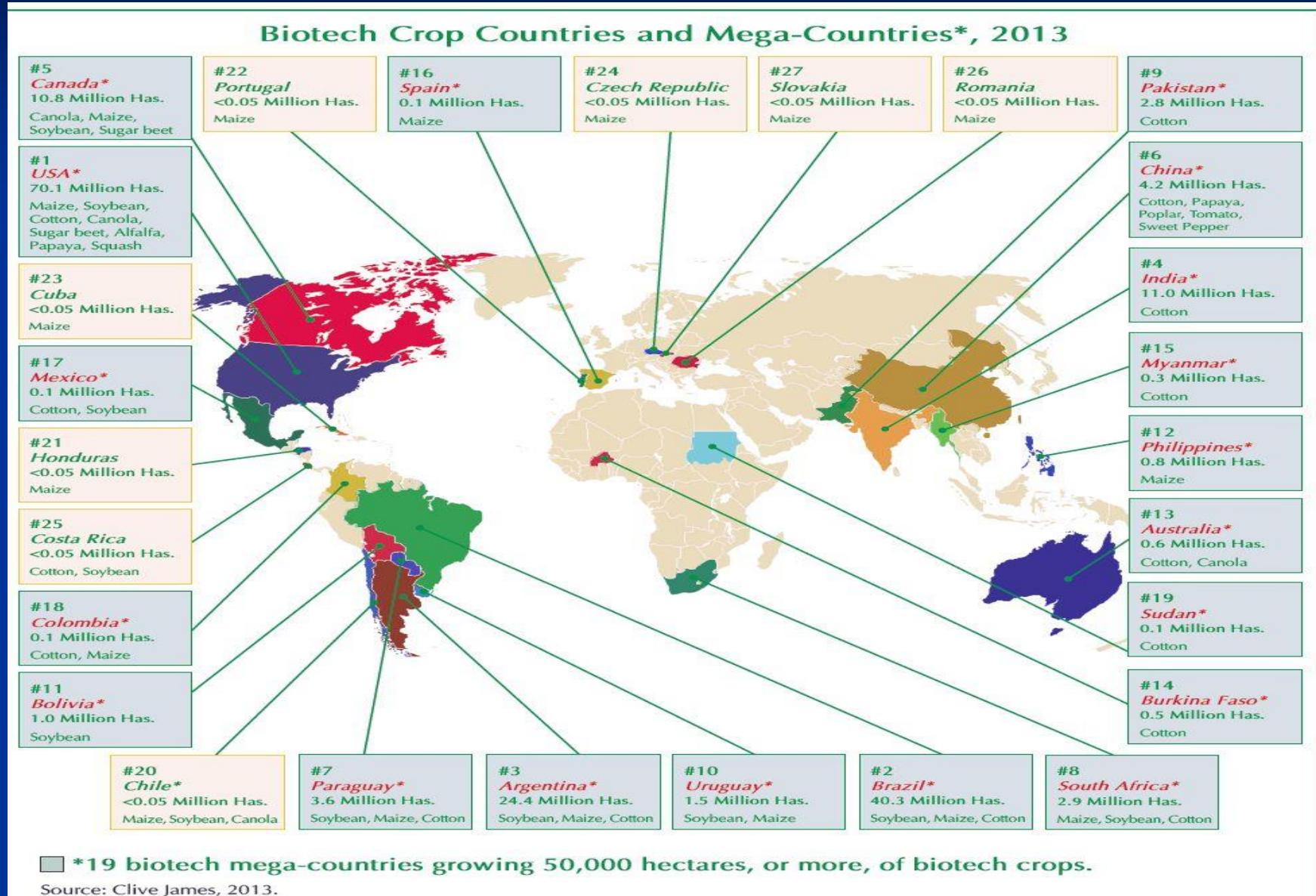
- USA
 - Corn > 90%
 - Cotton > 90%
 - Soybean > 90%
- Argentina: Soybean > 90%
- Canada: Canola > 90%
- India: Cotton > 90%

Farmers worldwide support GE technology!

Year by year growth of GM crops



Global distribution of GM crops



Scientific Consensus on Safety?

■ Generally positive

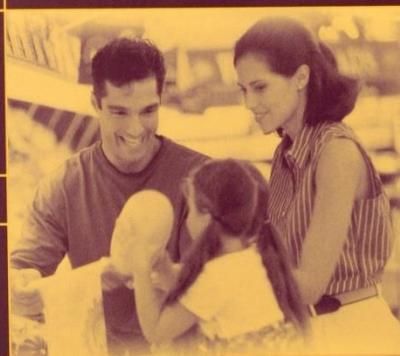
- * US National Academies
- * US Institute of Medicine
- * American Medical Association
- * British Royal Society
- * Royal Society of Medicine
- * EFSA
- * EU Economic Commission
- * World Health Organization
- * AAAS
- * American Dietetic Association
- * International Seed Foundation
- Etc, etc...

■ Generally negative



SAFETY OF GENETICALLY ENGINEERED FOODS

APPROACHES TO ASSESSING
UNINTENDED HEALTH EFFECTS



NATIONAL RESEARCH COUNCIL AND
INSTITUTE OF MEDICINE
OF THE NATIONAL ACADEMIES

Selection from a homogenous population



Selection from a heterogeneous population



Crossing of existing approved plant varieties*



rDNA via Agrobacterium, transfer of genes from closely related species



Conventional pollen based crossing of closely related species



Conventional pollen based crossing of distantly related species or embryo rescue



Somatic hybridization



Somatic variation (SCV)



rDNA biolistic transfer of genes from closely related species



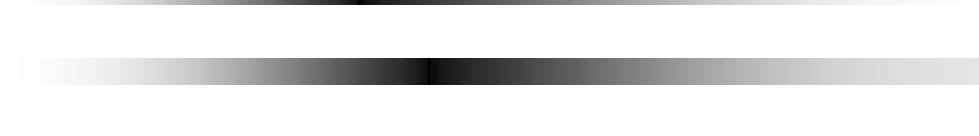
rDNA via Agrobacterium, transfer of genes from distantly related species



rDNA biolistic transfer of genes from distantly related species



Mutation breeding, chemical mutagenesis, ionizing radiation

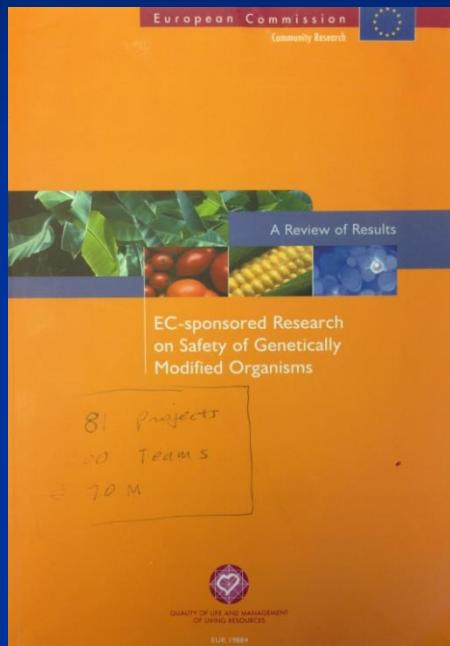


*includes all methods of breeding

NAS/IOM findings

- Genetic engineering is NOT inherently hazardous
- The risks of GE are similar to the risks posed by traditional forms of plant breeding
- There are NO documented adverse health effects from eating foods derived from GE crops.
 - Allegations of harm are plentiful, but all unfounded
 - Update: Still true as of April, 2014.

European Union Gov't funded research on GM safety



1985- 2000:
81 projects
400 public scientific teams,
70,000,000 Euros

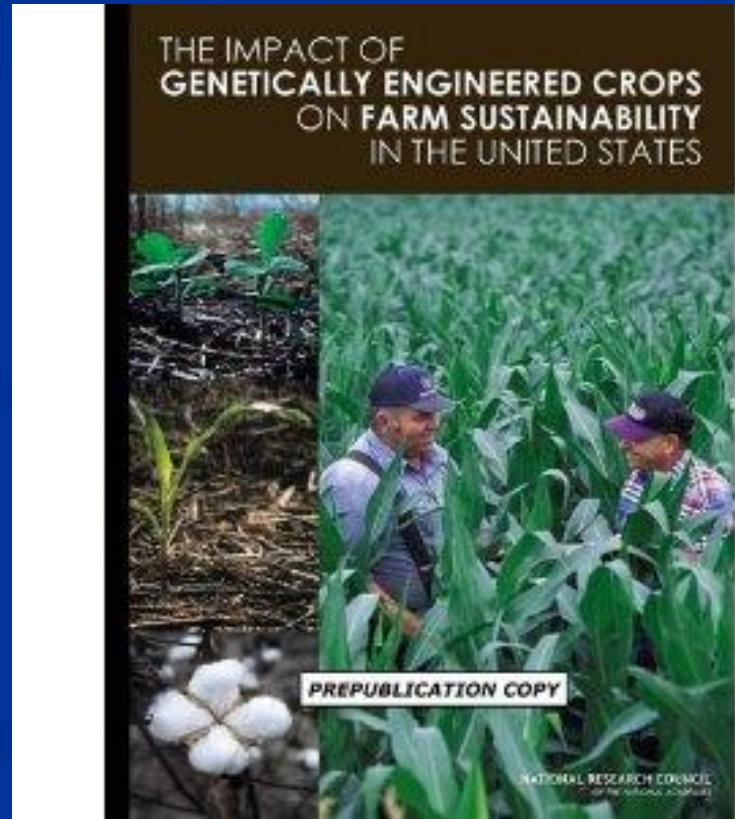


2000- 2010:
50 Projects
400 public scientific teams
200,000,000 Euros

Total: 25 years, 270M Euros

'Is AgBiotech farming sustainable?'

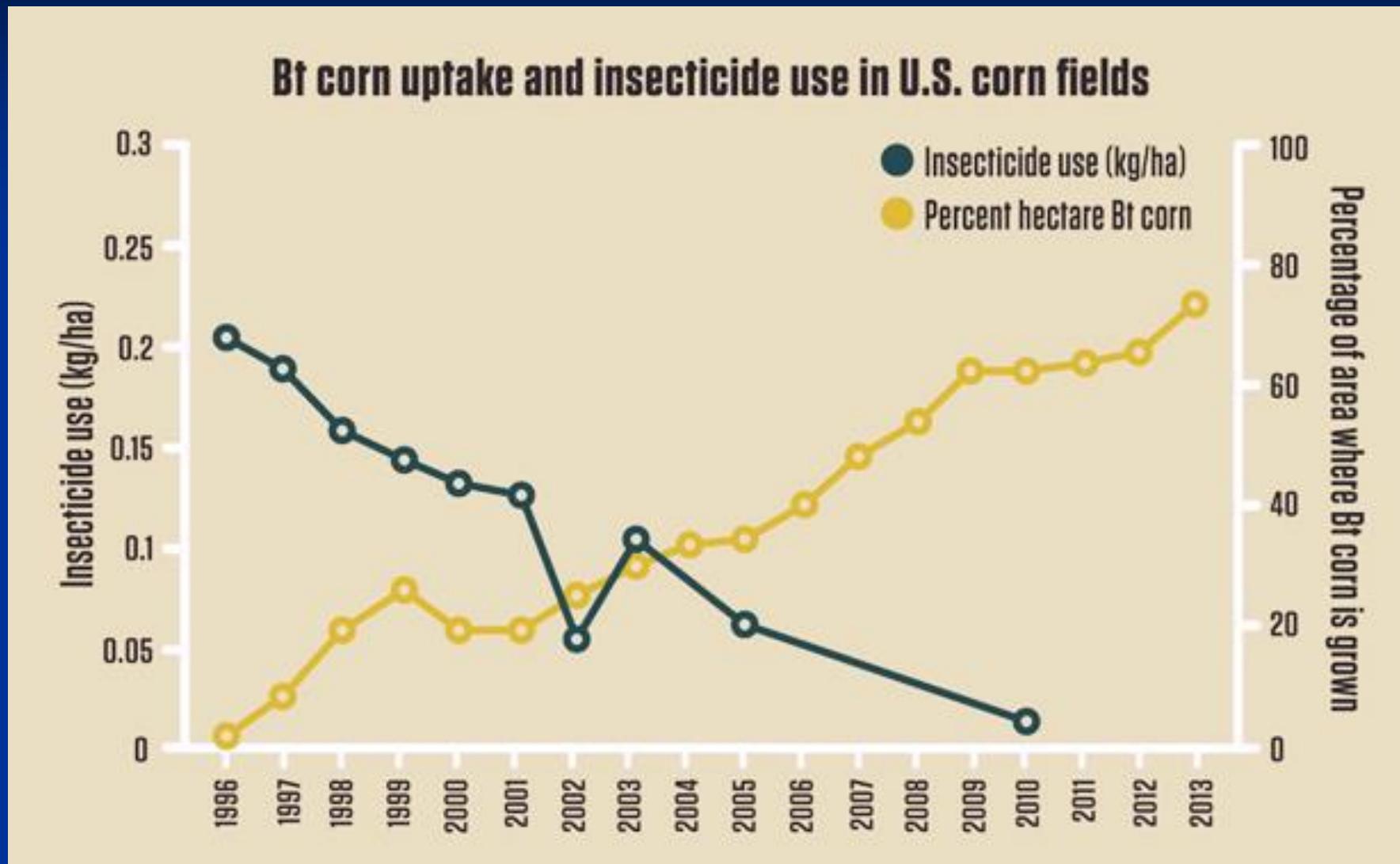
- US: NAS, 2010. Impact of GE crops on farm sustainability in the US
- *Also see:*
 - Brookes and Barfoot, 2014
 - Bonny, 2011
 - Qaim, 2009



Sustainability Impacts in the USA

- NAS Conclusions: Planting GE crops *generally* :
 - Is better for the environment than conventional crops
 - Uses less pesticide
 - Uses safer pesticides than those used in conventional cropping systems
 - Reduces tillage, leading to improvements in
 - Soil
 - Water
 - BUT: may lead to reliance on a single pesticide.

GM corn and pesticide usage USA



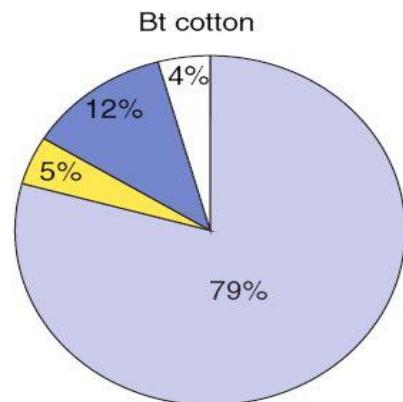
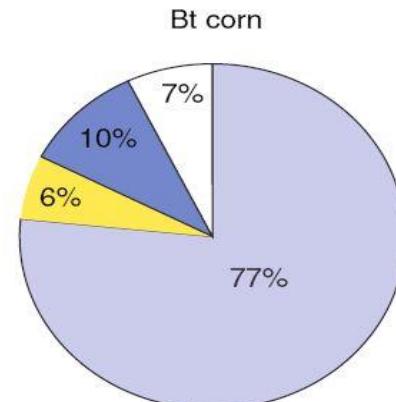
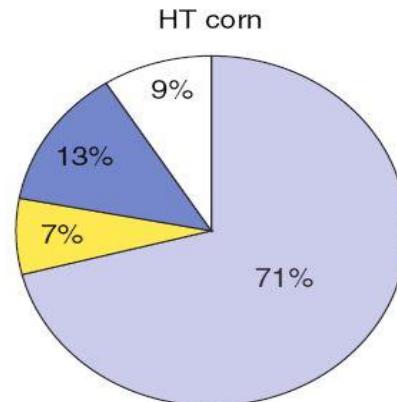
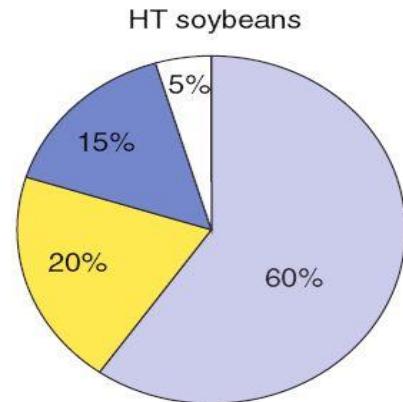
USDA-ERS (2014)

- Insecticide use has decreased with the adoption of insect-resistant crops
- Herbicide-tolerant crops have enabled the substitution of glyphosate for more toxic and persistent herbicides
- Overreliance on glyphosate and a reduction in the diversity of weed management practices have contributed to the evolution of glyphosate resistance in some weed species.

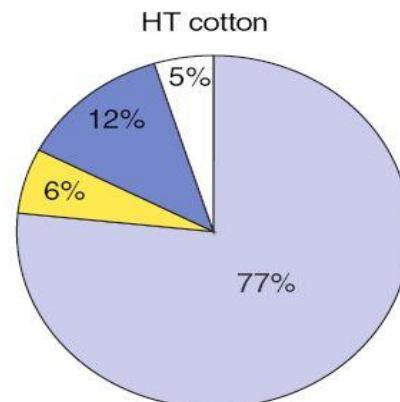
No yield increase with GM crops?

Figure 7

Farmers' reasons for adopting genetically engineered crops



- [Light blue square] Increase yields
- [Yellow square] Decrease pesticide input cost
- [Dark blue square] Save management time and make other practices easier
- [White square] Other



Bt crops have insect resistant traits; HT crops have herbicide tolerance traits.

Sources: USDA Economic Research Service using data from Agricultural Resource Management Survey (ARMS) Phase II surveys: 2010 for corn, 2007 for cotton, and 2006 for soybeans.

Conclusions

- Wherever farmers have been allowed to grow GM crops, they have been successful
- There is NO verified documentation of any harm, to either health or environment, due to GM crops and foods
- In spite of various political and regulatory obstacles, agricultural biotechnology is a proven valuable tool in providing safe, sustainable food, feed and industrial products.