Genetic Engineering & Agriculture: An Insider's View of GMOs

Bob Goldberg

10/31/16
The Politics of GMOs

Genetically Modified Salmon Is Safe To Eat, FDA Says

G.M.O. Labels for Food Proliferate Even as a Battle Over Them Rages

Colorado, Oregon Reject GMO Labeling

L.A. backpedals on proposal to ban growing genetically modified crops

Justices Back Monsanto on Biotech Seed Planting
What's a GMO?
What's a GMO?

A Genetically Engineered Bacteria Synthesizing Human Insulin Used as a Drug to Treat Diabetics?

A Genetically Engineered GloFish Used as a Pet?

A Genetically Engineered Pig With Double Muscles For Leaner & More Meat

A Genetically Engineered Yeast That Synthesizes Opiates For Medicine?
A Genetically Engineered Person With a Gene That They Weren’t Born With That “Cures” a Lethal Genetic Disease?

A Genetically Engineered Person With a Gene That They Weren’t Born With That “Cures” a Lethal Genetic Disease?

A Human Embryo With a Defective Blood Disease Gene That Was “Edited” and Engineered to Be Normal?

A Genetically Engineered Salmon That Grows Faster Than Non-Engineered Salmon & Has Been Approved by the FDA For Human Consumption?
So......What's a GMO?

Crops That Are Grown For For Human & Animal Consumption?
Genes Obey the Same Rules Using Either Classical or Molecular Genetic Engineering Approaches!!

Can Intervene in This Process in Cells

Genetic Engineering Is not “Hocus Pocus.” It Uses “Natural” Cell Processes!!!
Agriculture is Facing the Perfect Storm

Population Growth & Increased Demand For Food
Reduced Land For Agriculture
Scarcity of Natural Resources (e.g., Water)
Climate Change
Expanding Pest Habitats
We Face Major Challenges in Agriculture

Over the next 50 years we will need to produce more food than in the whole of human history and do it with fewer inputs on less arable land!!!!

Crop yields need to be increased significantly!!

World Population (millions)

40,000 Kids Die Each Day

40,000 Kids Die Each Day
There is a Constant Battle Between Crops & Environment That Affects Yield!!

**Abiotic (Drought, Heat) & Biotic (Insects, Fungi, Viruses) Stresses Reduce Crop Production (Yield) Worldwide Significantly**

Biotic Stress Results in 30-40% Crop Loss Per Year or $500B Annually!  
FAO Statistics

Abiotic Drought Stress Costs California Agriculture $1.84B and 10,000 jobs in 2015!  
UC Davis News & Information
Thus.....Crop YIELDS MUST Be Increased Using Every Discovery & Technique Available!
One Example From Los Angeles & UCLA History
A Sample of LA County Agriculture in the 1930s

600,000 Acres ~30% of LA County Total Area!!
Cash Value of $2.8B in 2014 Dollars!!

CROP REPORT
COUNTY OF LOS ANGELES
1934
OFFICE OF AGRICULTURAL COMMISSIONER

<table>
<thead>
<tr>
<th>CITRUS FRUITS*</th>
<th>Acres</th>
<th>Boxes</th>
<th>Cash Value</th>
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<td>Oranges</td>
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<td>9,211,900</td>
<td>$17,786,100</td>
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<tr>
<td>Lemons</td>
<td>3,134</td>
<td>2,063,000</td>
<td>5,923,000</td>
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<tr>
<td>Grapefruit</td>
<td>712</td>
<td>190,800</td>
<td>305,700</td>
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<table>
<thead>
<tr>
<th>OTHER FRUITS &amp; NUTS</th>
<th>Acres</th>
<th>Tons</th>
<th>Cash Value</th>
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<td>772</td>
<td>2,800</td>
<td>13,200</td>
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<tr>
<td>Apricots</td>
<td>1,008</td>
<td>504,000</td>
<td>70,600</td>
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<td>Almonds</td>
<td>2,191</td>
<td>4,260,000</td>
<td>393,100</td>
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<tr>
<td>Avocados**</td>
<td>772</td>
<td>980</td>
<td>66,000</td>
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<tr>
<td>Figs</td>
<td>1,919</td>
<td>7,000</td>
<td>76,800</td>
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<tr>
<td>Grapes-table</td>
<td>2,550</td>
<td>3,520</td>
<td>91,000</td>
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<tr>
<td>Grapes-vine</td>
<td>324</td>
<td>3,800</td>
<td></td>
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<tr>
<td>Grapes-raisin</td>
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<td>575</td>
<td>20,800</td>
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<td>Olives</td>
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<td>1,200</td>
<td>32,600</td>
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<td>Peaches-cling</td>
<td>986</td>
<td>1,700</td>
<td>56,100</td>
</tr>
<tr>
<td>Peaches-free</td>
<td>2,481</td>
<td>5,000</td>
<td>125,000</td>
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<tr>
<td>Pears</td>
<td>226</td>
<td>450</td>
<td>16,800</td>
</tr>
<tr>
<td>Persimmons</td>
<td>241</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td>Plums</td>
<td>54</td>
<td>110</td>
<td>2,200</td>
</tr>
<tr>
<td>Prunes</td>
<td>25,217</td>
<td>18,947,000</td>
<td>1,540,000</td>
</tr>
</tbody>
</table>

* Source: Crop Acreage Trends For LA County & Southern California, 1925-1954, Published by LA County Board of Supervisors, Compiled by LA County Chamber of Commerce UCLA Library OCLC21700378
Aerial Photograph of UCLA in 1929

There Were 18,000 Farms in Los Angeles County in 1930!!!

From 1901 to 1950 Los Angeles County Was the Highest Agricultural Producing County in the USA!!!

Bel-Air

Beverly Hills

Sunset Blvd.

Hilgard Blvd.

Westwood Blvd.

Original Agricultural College and Citrus/Avocado Orchard

Los Angeles Population = 1,238,000

Thelner Hoover
4/11/29
Original UCLA College of Agriculture-1930

Kinsey Hall
(Now Humanities Bld.)

Notice View of the SM Mountains
Avocado Rootstock Progeny Nursery on the UCLA Campus in 1936

CA Schroeder, Cal. Avocado Society Year Book, 76, 77-83 (1992)
Origins of Avocado Research

Avocado Variety Chart
Aerial Photograph of UCLA in 2016

Note: Loss of Crop Land!! Gone Forever!!

Los Angeles Population = 3,893,000
How Have Crop Yields Increased Over the Past 100 Years?
**Big Changes in the US Over The Past 100+ Years**

*“We’ve Come a Long Way Baby”*

<table>
<thead>
<tr>
<th>Category</th>
<th>1900</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Expectancy</td>
<td>48 (women)</td>
<td>81 (women)</td>
</tr>
<tr>
<td>Average Family Income (2016 Dollars)</td>
<td>$8,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Gasoline Use Per Capita</td>
<td>34 gallons</td>
<td>1,100 gallons</td>
</tr>
<tr>
<td>Flush Toilets Per Housing Unit</td>
<td>10%</td>
<td>99%</td>
</tr>
<tr>
<td>High School Grads</td>
<td>13%</td>
<td>90%</td>
</tr>
<tr>
<td>Farm Workers</td>
<td>55%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>
**Crop Yield Increases** have “rocketed upwards” over the last 100 years and contributed to a longer and “better” life.

### Bushels/Acre

<table>
<thead>
<tr>
<th>Year</th>
<th>1900</th>
<th>1920</th>
<th>1940</th>
<th>1960</th>
<th>1980</th>
<th>2015</th>
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<tbody>
<tr>
<td>Yield</td>
<td>30</td>
<td>30</td>
<td>40</td>
<td>60</td>
<td>100</td>
<td>185</td>
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</tbody>
</table>

**Conclusion:** Crop yields increased >500% over the past 100 years and lead to a similar reduction in food costs!!!!!
How Was This Accomplished Over the Past 100+ Years?
WHAT TECHNOLOGIES CAUSED AN INCREASE IN CROP YIELDS OVER THE PAST 100 YEARS?

- **PLANT BREEDING** (New Hybrids-Green Revolution)
- **IRRIGATION**
- **FERTILIZERS**
- **PESTICIDES & HERBICIDES**
- **MECHANIZATION** (e.g., Tractor)
- **GLOBAL POSITIONING AND SATELLITE IMAGING**
- **GENOMICS & GENETIC ENGINEERING** (New Traits)

These technologies have resulted in a >300% increase in US crop productivity!

Need to sustain this yield increase by applying the best technology and agricultural practices!
How Will Crop Yields Be Increased In the Next 100 Years?
Our Food is Derived From Fifteen Crops & Over Half Produce Seeds For Human and Animal Consumption
All of These Genomes Have Been Sequenced!

**Seed Crops**
- Wheat
- Rice
- Corn*
- Barley
- Sorghum
- Soybean*
- Common Bean
- Coconut
- Canola*

**Non-Seed Crops**
- Potato
- Sweet Potato
- Cassava
- Sugar Beet*
- Sugar Cane
- Banana

We Understand the Science of These Genomes – It’s No Longer a “Black Box” as in the Pre-Genomics Era!!!!

* Genetically Engineered
...By Using a Variety of Approaches to Identify Genes and Processes That Will Help Increase Crop Yields and Food Production Significantly in the 21st Century....

**Yield (Developmental Traits)**
- Seed Number
- Seed Size
- Growth Rate
- Organ Size *(More Seeds)*
- Plant Architecture
- Flowering Time
- Senescence
- Maturity
- Stature

**Yield (Stress Traits)**
- Nutrient Uptake
- Drought Resistance
- Heat Resistance
- Cold Tolerance
- Salt Tolerance
- Shade Tolerance
- Disease Resistance

...And by Using Genomics, Breeding, and Genetic Engineering to Introduce These “Yield” Genes Into Crops *(One thing we can be sure of—we can’t predict what new technology will be the driver 10-25 years out!)*
All Crops Have Been Engineered - Turning Wild Teosinte Into Domesticated Corn 10,000 Years Ago - Seed & Plant Engineering!!

Note: Architecture and Fruit (cob) Size

Only Five Genes Cause These Plants to Differ & We Now Know What They Are
Engineering Vegetables With Different Plant Architectures

Manipulating Existing Genetic Variability Brought About By Chance Mutations!

How Are These Plants Related?
The Problem With Breeding the “Old Fashioned Way”

Engineering A Novel Crop By "Wide" Breeding

Cabbage (Brassica) × Radish (Raphanus)

"Head" → "Storage Root"

Karpechenko 1925
Results Show the Unpredictability of Classical Breeding Approaches!!

Engineering A Novel Crop By "Wide" Breeding

Cabbage (Brassica)  Radish (Raphanus)

"Head"

Storage Root

Radish leaves!!!

RaphanoBrassica

Cabbage roots!!!
Classical vs. DNA or Molecular Genetic Engineering Techniques

TRADITIONAL PLANT BREEDING

Plant Breeding Combines Many Genes At Once

Desired Gene
(Many Crosses)

New Variety
Many Genes Transferred

PLANT BIOTECHNOLOGY

Biotechnology Adds A Single Gene

Or Many Cloned or Synthesized Genes

Gene Transfer (one generation)

One Gene Transferred

Or Many Genes

All Manipulate Genes - But in Different Ways!!
Genes Obey the Same Rules Using Either Classical or Molecular Genetic Engineering Approaches - BOTH Produce GMOs!

All Organisms Use The SAME Processes And “RULES” to Generate Traits!! And The SAME Molecules & Chemistry!!

Can Intervene in This Process in Cells

Genetic Engineering Is not “Hocus Pocus.” It Uses “Natural” Cell Processes!!!!
Genetic Engineering is a **TECHNIQUE**!

Breeding or DNA – It’s the Same & Called **Gene Manipulation**

**WHAT IS A GMO!!!!!!**
Crop Genetic Engineering Examples

- Drought Resistance
- Bacteria Pathogen Resistance
- More Biomass-Yield!
- Insect Resistance
- Anti-Oxidant Enhancement
- Golden Rice Vitamin A Fortification
- Edible Vaccines
- Ornamental Trait Blue Rose
- Bruise-Resistant Potatoes
- Non-Browning Apples
Example: How to Make an Insect-Resistant Plant?

Recall – Crops are in Perpetual Warfare With Pests

Bacillus thuringiensis

Bt Toxin in Spores

Crop is infected by European corn borer
Pest dies when feeding on any plant part

Hornworm
INSECT RESISTANCE with Bt

CONTROL Bt
Here's The Irony – The Bt Gene Used in Genetically Engineered Corn & Cotton Codes For EXACTLY the Same Protein Used in Organic Agriculture!! What's the Fuss About?

Bt is one of the safest natural pesticides you can use to control caterpillar pests without harming beneficial insects.

Photo Courtesy Safe Brand

Active Ingredient: 
Bacillus thuringiensis subspecie kurstaki strain SA-12 solids, spores and Lepidopteran active toxins (At least 6 million viable spores per mg)*. Other ingredients: . Total: .

*The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.
There are ten crops grown for human & animal consumption.

- Soybean
- Corn
- Canola
- Sugar Beet
- Alfalfa
- Arctic Apple
- Innate Potato
- Papaya
- Squash
- Cotton
Most Genetically Engineered Crops Are Fed To Animals or in Processed Foods

GMOs are found in 80% of packaged food in the US

Percentage of each Genetically Modified Crop that is grown in the United States

- 93% Soy
- 93% Cotton
- 90% Canola
- 86% Corn
- 95% Sugar Beets
- 80% Hawaiian Papaya
- 25,000 acres Zucchini & Crookneck Squash

Most Fruits & Vegetables Bought in Grocery Stores Are Not DNA-Spliced GMOs!
Most Fruits & Vegetables Bought in Grocery Stores Are Not DNA-Spliced GMOs!

These Are GMOs Produced By Selective Breeding
Genetic Engineering - Most Rapidly Adopted Technology in Agricultural History

2014 GLOBAL STATUS OF COMMERCIALIZED BIOTECH/GM CROPS

18 MILLION FARMERS BENEFITED FROM BIOTECH CROPS
90% SMALL, RESOURCE POOR FARMERS FROM DEVELOPING COUNTRIES

MORE DEVELOPING COUNTRIES GROW BIOTECH CROPS

28 COUNTRIES ALL OVER THE WORLD PLANT BIOTECH CROPS
20 DEVELOPING 8 INDUSTRIAL

TOP 5 COUNTRIES IN BIOTECH CROPS HECTAREAGE:

USA 73.1 Million Hectares
Brazil 42.2 Million Hectares
Argentina 24.3 Million Hectares
India 11.6 Million Hectares
Canada 11.6 Million Hectares

GLOBAL BIOTECH CROP AREA MARKS 19 YEARS (1996-2014) OF CONSECUTIVE GROWTH

1.7M 12% of Land in Cultivation 2014

181.5 MILLION HECTARES

1.8 BILLION HECTARES BIOTECH CROPS PLANTED SINCE 1996

MAJOR BIOTECH CROPS
SOYBEAN
MAIZE
COTTON
CANOLA

OTHER BIOTECH CROPS
SUGAR BEET
ALFALFA
PAPAYA

FIRST COMMERCIAL PLANTING OF Bt BRINJAL/EGGPLANT IN BANGLADESH
POLITICAL WILL AND PUBLIC-PRIVATE PARTNERSHIP WERE ESSENTIAL FOR SUCCESS

HERBICIDE TOLERANCE IS DOMINANT TRAIT DEPLOYED IN SOYBEAN, MAIZE, CANOLA, COTTON, SUGAR BEET, & ALFALFA
Also Insect Tolerance & Viral Resistance
FOOD SAFETY IS A MAJOR ISSUE

Estimates of Foodborne Illness in the United States

CDC estimates that each year roughly 1 in 6 Americans (or 48 million people) get sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases. Estimating illnesses, hospitalizations, and deaths for various types of diseases is a common and important public health practice.

Estimating the number of illnesses associated with specific food sources is called foodborne illness source attribution. These analyses are the logical extension of our 2011 analyses estimating the burden, or number, of foodborne illnesses, hospitalizations, and deaths in the US.
How Many Genes Did You Eat Today?

- One Lettuce Leaf Has Two Million Cells
- Each Lettuce Cell Has ~25,000 Genes
- One Lettuce Leaf Has Fifty Billion Genes
- A Small Salad Has 10 Lettuce Leaves Or Five Hundred Billion Genes!!!

What About the Carrots, Celery, Tomatoes, etc.?

What Happens to the Genes That You Eat?

<table>
<thead>
<tr>
<th>Protein Studied*</th>
<th>IC50**</th>
<th>Stable to Digestion?</th>
<th>Stable to Processing?</th>
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</thead>
<tbody>
<tr>
<td>Cry1Ac</td>
<td>&gt;4900</td>
<td>No (35%)</td>
<td>No</td>
</tr>
<tr>
<td>Cry1Ab</td>
<td>&gt;5000</td>
<td>No (35%)</td>
<td>No</td>
</tr>
<tr>
<td>Cry2Ac</td>
<td>&gt;4111</td>
<td>No (35%)</td>
<td>No</td>
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<tr>
<td>Cry2Ab</td>
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<td>No (35%)</td>
<td>No</td>
</tr>
<tr>
<td>Cry3A</td>
<td>&gt;5220</td>
<td>No (35%)</td>
<td>No</td>
</tr>
<tr>
<td>Cry3Bb</td>
<td>&gt;3780</td>
<td>No (35%)</td>
<td>No</td>
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<tr>
<td>Cry3C</td>
<td>&gt;3780</td>
<td>No (35%)</td>
<td>No</td>
</tr>
<tr>
<td>NPT II</td>
<td>&gt;5000</td>
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<td>No</td>
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<tr>
<td>CNPase</td>
<td>&gt;572</td>
<td>No</td>
<td>N.A.</td>
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<tr>
<td>GluS</td>
<td>&gt;150</td>
<td>No</td>
<td>N.A.</td>
</tr>
</tbody>
</table>
These are the MOST Tested Plants Ever!!!
More Than Any Food Produced by Classical Breeding Methods!!!
Average Cost = $150M

There is NO Testing For Conventional or Organic Foods!

National Academy of Sciences Report: Focus on the Food Not the METHOD of Production!!!

Similar to Those Used For Antibiotics, Vaccines, and Drugs!!
Genetically Engineered Crops Are the Most Tested Crops in Agricultural History!

GMO RESEARCH, REVIEW AND REGULATION

- **On average, GMOs take 13 years and $130 million of R&D BEFORE coming to market.**
- **The regulatory process alone can take 5 to 7 years.**

REGULATORY SCIENCE

- **75+ different studies** are conducted to demonstrate each new GMO is:
  - **Safe to grow**
    - Crop grows the same as non-GM varieties
    - Crop exhibits expected characteristics (e.g., insect resistance)
  - **Safe for the environment and beneficial insects**
  - **Safe to eat**
    - Same nutrients as non-GM crops
    - No new dietary allergens

REGULATORY REVIEW

- More than **90 government bodies** globally review and approve GMOs. In many countries, multiple agencies are involved in the regulation of GMOs.
- GMOs have been grown or imported by **70 countries** since 1996.

U.S. REGULATORY AGENCY REVIEWS

- **USDA > Safe to grow**
- **EPA > Safe for the environment**
- **FDA > Safe to eat**

For more information, visit [www.GMOAnswers.com](http://www.GMOAnswers.com)
Which Food Would YOU Eat?

- No Testing
- No Regulatory Oversight
- Contains Known Allergen
- 9,000 Hospitalizations Per Year

- Extensive Testing (~10 years)
- FDA, USDA, & EPA Oversight
- Eaten By Billions of People
- No Documented Health Problems

Researchers Develop First Hypoallergenic Soybeans

Will These Ever Get To The Market?
Safety Issues of Genetically Engineered Plants Have Been Investigated and Discussed For 35 Years - Thousands of Studies - Unanimous Conclusion - GMOs are Safe For Human Consumption!!
“The AMA adopted policy supporting this science-based approach, recognizing that there currently is no evidence that there are material differences or safety concerns in available bioengineered foods.”

“To date no adverse health effects attributed to genetic engineering have been documented in human populations.”

“The scientific literature shows no compelling evidence to associate such crops, now cultivated worldwide for more than 15 years, with risks to the environment or with safety hazards for food.”
There Is Major Public Skepticism About GMOs!!!

Public and Scientists’ Views on Science and Society 2015

51 Point Gap!!

- Safe to eat genetically modified foods
  - Public: 37%
  - Scientists: 88%

- Unsafe to eat
  - Public: 37%
  - Scientists: 88%

How Do We Change This?

• Increased Crop Value by $78B
• ~75% of Crop Added Value Went to Small Farmers
• Reduced Pesticide Use 37% or 200M Pounds!
• Reduced CO₂ Emissions by 40B Pounds or the Equivalent of Taking 9M Cars Off the Road
• Saved Billions of Tons of Topsoil by Using No-Till Farming (1B per year)
• Improved the Health of Farmers in Developing Countries (Reduced Pesticides)
• Contributed to Reduced Food Costs in the US and Elsewhere

Brookes & Barfoot, GM Crops & Food, 4, 74-83; ISAAA Brief 46-2013; Klumper & Qaim, PLOS One, (11), 2014
A Meta-Analysis of the Impacts of Genetically Modified Crops

Funded by German Federal Ministry of Development & European Union

Wilhelm Klümper, Matin Qaim*

Department of Agricultural Economics and Rural Development, Georg-August-University of Goettingen, Goettingen, Germany

Abstract

Background: Despite the rapid adoption of genetically modified (GM) crops by farmers in many countries, controversies about this technology continue. Uncertainty about GM crop impacts is one reason for widespread public suspicion.

Objective: We carry out a meta-analysis of the agronomic and economic impacts of GM crops to consolidate the evidence.

Data Sources: Original studies for inclusion were identified through keyword searches in ISI Web of Knowledge, Google Scholar, EconLit, and AgEcon Search.

Study Eligibility Criteria: Studies were included when they build on primary data from farm surveys or field trials anywhere in the world, and when they report impacts of GM soybean, maize, or cotton on crop yields, pesticide use, and/or farmer profits. In total, 147 original studies were included.

Synthesis Methods: Analysis of mean impacts and meta-regressions to examine factors that influence outcomes.

Results: On average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%. Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops. Yield and profit gains are higher in developing countries than in developed countries.

Limitations: Several of the original studies did not report sample sizes and measures of variance.

Conclusion: The meta-analysis reveals robust evidence of GM crop benefits for farmers in developed and developing countries. Such evidence may help to gradually increase public trust in this technology.

However... There’s a Battle Raging to Get Bioengineered Crops Banned in Many Parts of the World
The GMO “Controversy” is Complex and Not Science Based

- Successful Well-Financed Anti-GMO “Propaganda” Campaign
- Perceived “Negative” Health Effects
- Bogus Science Studies Sensationalized by the Popular Media
- **Organic Growers/Markets** - Gain Market Share (Follow the $!!)
- Anti-Globalization - Anti-Patent/Intellectual Property
- Industrial-Oriented Conventional Farming That Uses GMOs
- Anti-Large American AgBiotech Companies (e.g., Monsanto)
- Labeling - Right to Know and Choose What is Eaten
- “Perceived” Negative Health Effects
- No Obvious Consumer Benefits
- Ecological & Environmental Issues (e.g., Pollen Flow)
- Lack of Public Science Awareness
A Tale of Two Giants

NET SALES (IN BILLIONS)

YEAR | 2009 | 2010 | 2011 | 2012 | 2013
---|---|---|---|---|---
| $8.0 | $9.0 | $10.1 | $11.7 | $12.9

Follow the Money

NET SALES
In billions of dollars, for years ended Aug. 31

| YEAR | 2009 | 2010 | 2011 | 2012 | 2013
---|---|---|---|---|---
| 13.50 | 14.86 | 15.85 |
What Has Been Some of the Real Life Affects of the GMO Controversy?

AFRICAN COUNTRIES REJECT GM FOOD AID

Zimbabwe and Zambia have rejected genetically modified food donations intended to avert drought-induced food shortages. Wisdom Mkumngani reports for Harare that participants at an international conference on genetic engineering and sustainable agriculture in Lusaka, Zambia commended the countries' decision to mill some of the donated food instead.

Dr. Luke Mumba, chairman of the Biosafety Council of Zambia and research of the University of Zambia, commented that while there was respect for the two countries' decision, there was need to adopt safe biotechnological advances, and that the use of GM technology could contribute to the complex problems of alleviating poverty and malnutrition. Meanwhile, Zambian Minister of Science and Technology Judith Kapupungu said the problem of food insecurity in Africa was a result of complex issues that required an integrated approach for sustainability.

See the article in http://allafrica.com/stories/200510110710.html.

Destroying Golden Rice Test Plots

Greenpeace’s Crime Against Humanity
8 Million Children Dead
AllowGoldenRiceNow.org
Nobel Laureates Line Up To Support GMOs And Push Back Greenpeace
The End... or The Beginning?