CENTER FOR FOOD SAFETY

The Failed Promise of Agricultural Biotechnology

Canadian Organic Growers – Toronto Conference
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Center for Food Safety

- Non-profit (NGO) founded 1997
- Support organic and other forms of sustainable agriculture
- Critically assess new food and agricultural technologies, like cloning, GMOs
- Public education, engagement in regulatory process, when necessary lawsuits

www.centerforfoodsafety.org

Facts vs. Fiction

- Focus on GMOs actually being grown rather than experiments in the laboratory or field tests
- Consult independent studies and data, for instance USDA data on pesticide use, crop yield
- GM crops vs. agroecological approaches in developing countries

Biotech Posterchild Crops

- Despite > 2 decades of experimentation, **not a single, commercially grown GMO has:**
  - Higher yield potential
  - Nutritional enhancement
  - Drought tolerance
  - Salt tolerance
  - Pharmaceutical production, etc.

Source: Time Magazine - Sunday, July 23, 2000

The biotechnology industry talks endlessly of attractive-sounding experimental GM crops in laboratories and test fields, but such crops are somehow never brought to market. One example of a failed "miracle" GM crop is described below. For a documented analysis of the biotechnology industry and its true goals, see: Freese, B. (2009). "Why GM Crops Will Not Feed the World," GeneWatch, Volume 22 Issue 1, Jan-Feb 2009. http://www.councilforresponsiblegenetics.org/GeneWatch/GeneWatchBrowser.aspx?archive=yes&volumeId=22&issueNumber=1

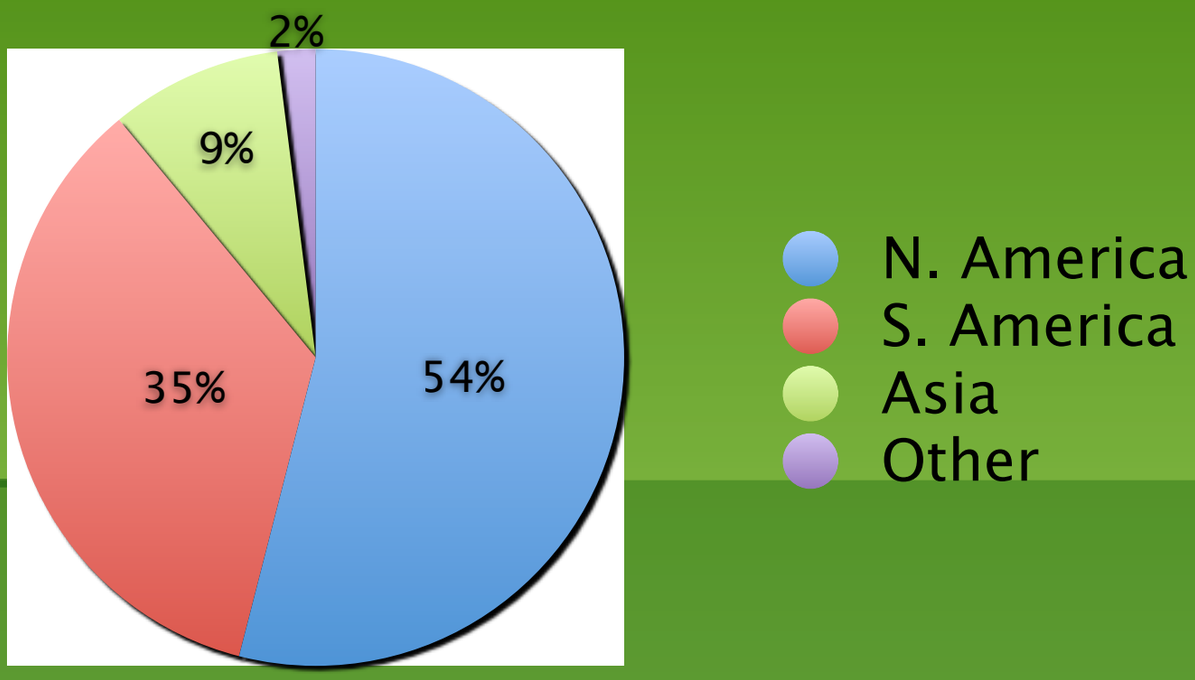
So-called "golden rice" is genetically engineered to contain higher levels of beta-carotene, a substance that is broken down in the body to form Vitamin A. "Golden rice" has been presented as a possible solution to diseases (e.g. blindness) involving deficiencies in Vitamin A. However, eleven years after publication of this article in Time Magazine, not a single child has been helped by "golden rice," and there is no clear indication that it will ever be introduced. Even if it is introduced, nutritionists have noted that the poor may not benefit, because poor people normally do not have sufficient fats in their diets, and fat is necessary for the body to absorb beta-carotene. These nutritionists note that increasing dietetic diversity is the best means to alleviate malnutrition, not nutritionally altered crops like "golden rice."

See: Nestle, Marion (2001). "**Genetically Engineered "Golden" Rice is Unlikely to Overcome Vitamin A Deficiency," Letter to the Editor, *Journal of the American Dietetic Association*,** Volume 101 (March): 289-290.

For more on nutritionally altered GM crops, see: Freese, B. (2008). "Is Biotech the Solution to Malnutrition?" Hunger & Environmental Nutrition Group of the American Dietetic Association, FALL 2008 Newsletter, pp. 6-7. http://www.eatrightsa.org/nutrition/features/Fall_2008_HEN_Newsletter.pdf.

Where are GM Crops Grown?

(% of world GM crop acreage, 2009)



Source: International Service for Acquisition of Agribiotech Applications (ISAAA), 2009

Source: ISAAA (2009). "Global Status of Commercialized Biotech/GM Crops: 2009 - The first fourteen years, 1996 to 2009." ISAAA is an organization funded by the biotechnology industry to spread misinformation about GM crops. Friends of the Earth International and Center for Food Safety have published several reports debunking ISAAA misinformation. For example, see: http://www.centerforfoodsafety.org/2008/02/13/genetically-modified-gm-crops-increase-pesticide-use-and-fail-to-alleviate-poverty-reveals-new-report/.

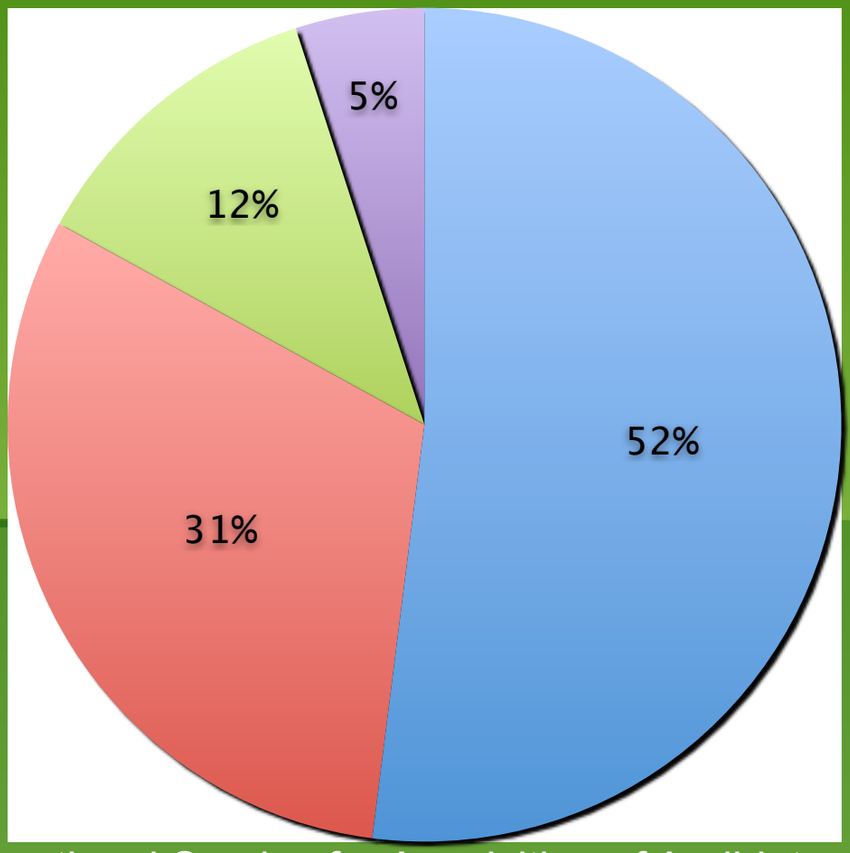
Unfortunately, we know of no other source of data on use of GM crops internationally, and so use ISAAA figures for this pie chart and the two that follow.

ISAAA reports 134 million hectares of GM crops grown internationally in 2009.

North America: U.S. (64.0 mill. ha), Canada (8.2) and Mexico (0.1) = 54.0% of global hectarage.
South America: Brazil (21.4), Argentina (21.3), Paraguay (2.2), Uruguay (0.8) and Bolivia (0.8) = 34.7% of global hectarage.
Asia: India (8.4, all cotton), China (3.7), Philippines (0.5), Australia (0.2) = 9.6% of global hectarage (rounded down to 9% to give 100% total)
Africa: South Africa (2.1), Burkina Faso (0.1) = 1.6% of global hectarage
Europe: Spain (0.1) = 0.1%
Other: various countries which together have roughly 0.1 million hectares = 0.1% of global hectarage.

Which Crops are GM?

(% of world GM crop acreage, 2009)



Source: International Service for Acquisition of Agribiotech Applications (ISAAA), 2009

For source, see previous slide.

	Million hectares	Percent
▪Soybeans:	69.2	52%
▪Corn:	41.7	31%
▪Cotton:	16.1	12%
▪Canola:	6.4	5%
▪Alfalfa, sugar beets	0.6	<0.5%
TOTALS:	134.0	100%

Source: International Service for Acquisition of Agribiotech Applications (ISAAA), 2009.

Note: GM sugar beets and alfalfa (both Monsanto's Roundup Ready varieties) are grown in the US. Federal courts in the US have ruled that the U.S. Dept. of Agriculture approved these crops illegally, resulting in partial prohibition of planting. As of early 2011, both Roundup Ready crops are being grown on a limited basis, and their continued cultivation is being challenged in court.

Food Companies Reject

- McDonald's and Burger King killed GE potatoes in 2000
- Gerber's (baby foods) – non-GE policy
- Del Monte – no to GE sweet corn
- Popcorn Board – no to GE popcorn
- Whole Foods, Wild Oats and Trader Joe's do not use GM ingredients in store brands

Sources:

For documented overview, see: CFS (2006). "Market Rejection of Genetically Engineered Foods," Center for Food Safety, August 2006.

http://www.centerforfoodsafety.org/pubs/Market%20rejection%20fact%20sheet%20Aug%202006.pdf.

Note: Roundup Ready sugar beets, once rejected by sugar beet growers, are now being grown in the U.S., though this GM crop remains the subject of litigation due to the U.S. Dept. of Agriculture's failure to conduct a science-based assessment and establish science-based regulations for cultivation of this crop.

Kilman, Scott (2000). "McDonald's, Other Fast-Food Chains Pull Monsanto's Bio-Engineered Potato," Wall Street Journal, April 28, 2000.

Farmer/Commodity Group Reject Some GMOs

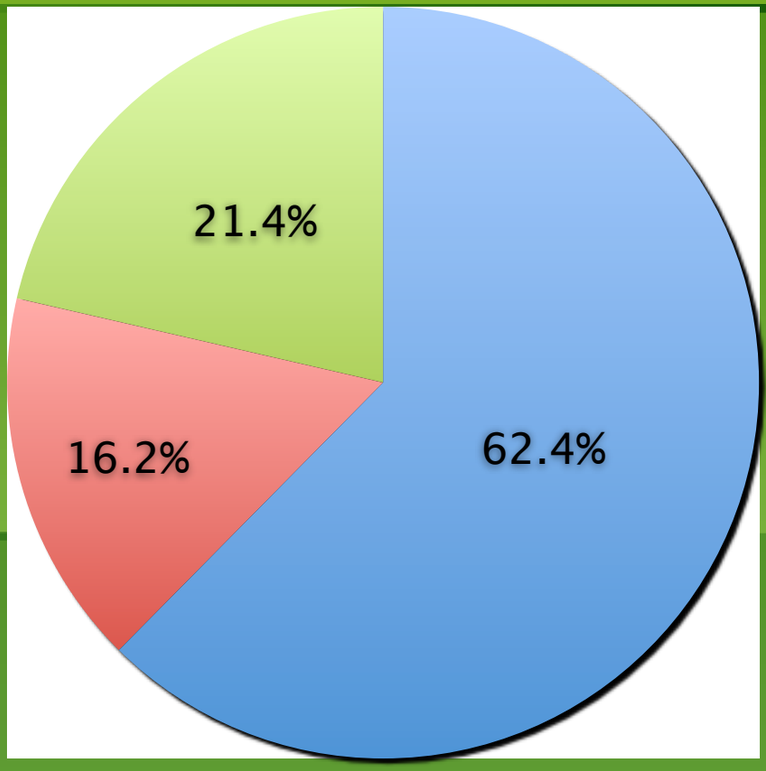
- Monsanto shelved Roundup Ready wheat 2004 – farm groups, wheat traders
- Millers and value-added producers have blocked intro of LibertyLink rice
- Flax Council of Canada forced deregistration of sulfonylurea-tolerant flax in 2001

Source: See previous slide for wheat and rice.

For flax, see: Schmidt, G. & B. Breckling (2010). "The Triffid case: A short resume on the re-discovery of a de-registered GMO," at: http://www.gmls.eu/beitraege/GMLS2_Schmidt-Breckling.pdf.

GM Crops by Trait(s)

(% of world GM crop acreage, 2009)



Herbicide-tolerant crops (with or w/o insect resistance) comprise 5 of every 6 acres (84%) of GM crops worldwide (Source: ISAAA (2009)

Source: ISAAA (2009). See previous pie charts for details on source.

	Million hectares	Percent
Herbicide resistance	83.6	62.4%
Insect resistance	21.7	16.2%
Stacked (both traits)	28.7	21.4%
TOTAL	134.0	100%

Note: For insect-resistant crops, there is a discrepancy between the figures ISAAA reports for hectares (21.7 million) and percentage (15%). 21.7 million hectares is in fact 16.2%, not 15%, of the total GM crop area of 134 million acres.

Herbicide-Resistant (HR) Crops

- Survive direct application of herbicide that would kill conventional crop
- Simplifies weed control, saves labor; facilitates trend to ever fewer, bigger farms
- Roundup Ready (glyphosate-resistant) soybeans, corn, cotton, canola grown on roughly 61 million ha in U.S. alone
- Near total reliance on glyphosate → Roundup-resistant weeds

Sources:

On benefits of herbicide-resistant crops, see: Duffy, Michael, Ph'D (2001). "Who Benefits from Biotechnology?" presentation at the American Seed Trade Association meeting December 5-7, 2001, Chicago, IL. Dr. Duffy is an agronomist at Iowa State University. http://www.leopold.iastate.edu/pubs/speech/files/120501-who_benefits_from_biotechnology.pdf.

On acreage of Roundup Ready crops in 2009, see: http://www.monsanto.com/investors/documents/2009/q4_biotech_acres.pdf.

Roundup-Resistant Weeds

- Populations of 21 weed species now resistant to glyphosate; 12 in U.S.
- Infest > 4 million ha. in U.S. alone since year 2000; **15 million ha. projected by 2013**
- How do farmers respond to resistant weeds?
  - Increase pesticide use and pollution
  - Increase soil-eroding tillage (abandon conservation tillage)
  - Go back to hand-weeding

Sources: Statistics on Roundup-resistant weeds (= glyphosate-resistant weeds) are from the International Survey of Herbicide Resistant Weeds, a website that tracks emergence of herbicide-resistant weeds that is supported by the pesticide industry and academic weed scientists.

Home Page: http://www.weedscience.org/In.asp

Glyphosate-resistant weeds (note that glyphosate is the only member of the "Glycines" class of herbicides): http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go.

Center for Food Safety (CFS) has collated data reported on this website for glyphosate-resistant (GR) weeds since November 2007. The area infested with GR weeds has quadrupled over the past three years, from 2.4 to 10.4 million acres (1.0 to 4.2 million hectares). For more, see CFS comments on the weed resistance risk posed by Roundup Ready (RR) sugar beets and other RR crops: http://www.centerforfoodsafety.org/wp-content/uploads/2010/12/RRSB-Partial-Dereg-EA-Science-Comments-BF.pdf.

For 10.4 million acres figure, see: "WSSA supports NRC Findings on Weed Control," Weed Science Society of America, 5/27/10. Weed scientist Dr. Ian Heap, who runs the International Survey of Herbicide-Resistant Weeds (www.weedscience.com), is cited for the statement that 6% of the total area planted to corn, soybean and cotton in the U.S. [which is 173 million acres] is infested with GR weeds. http://www.wssa.net/WSSA/Information/WSSA%20position%20paper%20on%20herbicide%20resistance%205-27-2010.pdf.

For the projection of 38 million acres (= 15.4 million hectares) by 2013, see: Syngenta (2009). "Leading the Fight against Glyphosate Resistance," quoting Chuck Foresman, manager of weed resistance strategies. http://www.syngentaebiz.com/DotNetEBiz/ImageLIbrary/WR%203%20Leading%20the%20Fight.pdf.

Increased Pesticide Use

- **Pesticide = any chemical used to kill a pest (weed, insect, disease agent)**

- **GM crops increased pesticide use in U.S. by 318.4 million pounds from 1996-2008**

  + Herbicide-resistant: + 382.6 million

  + Insect-resistant: - 64.2 million

"Impacts of Genetically Engineered Crops on Pesticide Use in the United States: The First Thirteen Years," Dr. Charles Benbrook, The Organic Center, Nov. 2009. http://www.organic-center.org/science.pest.php?action=view&report_id=159

On increased pesticide use with GM crops, see:

Benbrook, C (2009). "Impacts of Genetically Engineered Crops on Pesticide Use in the United States: The First Thirteen Years," The Organic Center, November 2009. http://www.organic-center.org/science.pest.php?action=view&report_id=159.

The author, Dr. Charles Benbrook, is the former executive director of the Board on Agriculture of the U.S. National Academy of Sciences. The report gives a documented summary of the adverse impacts of several glyphosate-resistant weeds (Chapter 4) and debunks misinformation on GM crops and pesticide use from pesticide industry-funded (i.e. Brookes and Barfoot) (pp. 48-51).

A few early warnings on the growing resistance of weeds to Roundup:

"Resistance to glyphosate (Roundup) is emerging all around the world, potentially jeopardizing the 2.5 billion dollar market for genetically modified herbicide tolerant crops."
"Glyphosate resistance is showing a worldwide rise," Farmers Weekly, November 23, 2001

"Scientists said they had to spray the weeds [horseweed] with 10 times the recommended rate of the herbicide to kill the plants. ... some farmers are considering growing Roundup Ready corn in addition to Roundup Ready soybeans, and that could increase use of the weed-killer and speed up the spread of resistant weeds, some scientists say."
"Roundup-resistant weeds are cropping up," by Philip Brasher, Des Moines Register, Jan. 10, 2003

"Genetics and herbicide use are contributing to the rise of a strong strain of horseweed, troubling farmers who likely will have to spend millions of dollars to fight the plant that is immune to a common weed-killer" [i.e. Roundup].... A weed scientist ... said it could cost "the state's [Arkansas] farmers as much as $9 million to combat it next year."
"Weed could cost farmers millions to fight," Associated Press, June 4, 2003.

Glyphosate-resistant horseweed in soybeans: https://www.syngentaebiz.com/DotNetEBiz/ImageLibrary/horseweed.jpg.

For other photos, see:
http://www.syngentaebiz.com/dotnetebiz/imagelibrary/WR%20Topical%20Info%20Sheet-Revised%20FINAL.pdf.

Common responses to combat glyphosate-resistant horseweed include use of 2,4-D and tillage.

For documented summary of the impacts of several glyphosate-resistant weed species, see Benbrook (2009), op. cit., Chapter 4.

Glyphosate-resistant pigweed (Palmer amaranth) in cotton in the South (e.g. Georgia, Arkansas, North Carolina) has forced cotton growers to spend millions on hand weeding crews to “chop cotton,” something not seen for decades.

For another photo of glyphosate-resistant Palmer amaranth, see: http://gibbs-soell.signal-mail.com/images/agweb_blog/Palmer%20amaranth%205.

See Charlier, T. (2009). “'The perfect weed': An old botanical nemesis refuses to be rounded up,” Memphis Commercial Appeal, August 9, 2009. http://www.commercialappeal.com/news/2009/aug/09/the-perfect-weed/

In 2009, 500,000 acres (200,000 hectares) were weeded by hand in Georgia alone, at a cost of $11 million. Cotton farmers’ weed control costs rose from$25/acre to $60-100/acre. Some cotton farmers will likely be driven out of business. See: Haire, B. (2010). “Pigweed threatens Georgia cotton industry,” Southeast Farm Press, July 6, 2010. http://southeastfarmpress.com/pigweed-threatens-georgia-cotton-industry.

Another weed closely related to Palmer amaranth, known as tall waterhemp (*Amaranthus tuberculatus*), is rapidly becoming a serious threat in the Midwest, where populations resistant to glyphosate and several other herbicides are prevalent. According to University of Illinois weed experts: “Herbicide resistance in *A. tuberculatus* appears to be on the threshold of becoming an unmanageable problem in soybean.” They go on to warn that if these weeds evolve resistance to glufosinate, one of the few herbicides that remain effective: “soybean production may not be practical in many Midwest U.S. fields.” See: Tranel, P.J. et al (2010). “Herbicide Resistances in Amaranthus tuberculatus: A Call for New Options,” Journal of Agricultural and Food Chemistry, DOI:10.1021/jf103797n.

Glyphosate-resistant Johnsongrass in Argentina (also found in Arkansas, Louisiana and Mississippi). Jonnsongrass is a perennial, one of the world's worst weeds even without glyphosate-resistance.

Photo from: Service, R.F. (2007). "A growing threat down on the farm," Science 316: 1114-1117.

For glyphosate-resistant Johnsongrass, see links at #20, Sorghum halapense at http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go.

See also: http://deltafarmpress.com/soybeans/johnsongrass-scott-0319/

Roundup-Resistant Weeds, So What?

"Globally, no weed control tools are as good as glyphosate, and its potential widespread loss because of resistance is a looming threat to global cropping and food production."

Dr. Stephen Powles, Western Australian Herbicide Resistance Initiative, in Proc. of the National Academy of Sciences, 107(3): 955-56, 1/19/10

"It is the single largest threat to production agriculture that we have ever seen," said Andrew Wargo III, the president of the Arkansas Association of Conservation Districts.

"U.S. Farmers Cope With Roundup-Resistant Weeds," NYT, 5/4/10

"Right now, we are on the edge of a precipice that we could step off of in the next two years."

Dr. Micheal Owen, Iowa State University weed scientist, as quoted in: "Reeling from resistance," *Successful Farming,* 1/26/10.

Dr. Stephen Powles is one of the most eminent weed scientists in the world, and has special expertise in the area of herbicide-resistant weeds. He is also a farmer who grows Roundup Ready canola, and wants to see glyphosate-resistance technology retain its efficacy for years to come, rather than become useless due to continued epidemic spread of weed resistance.

From: Powles, S.B. (2010). "Gene amplification delivers glyphosate-resistant weed evolution," Proc. of the National Academy of Sciences, 107(3): 955-56.

Andrew Wargo is concerned by farmers' abandonment of no-till and conservation tillage practices in response to glyphosate-resistant weeds. That is, many farmers with GR weeds make increasing use of soil-eroding tillage to remove them. For more, see: Pollack, A. (2010). "U.S. Farmers Cope with Roundup-Resistant Weeds," New York Times, May 4, 2010. http://www.nytimes.com/2010/05/04/business/energy-environment/04weed.html

Dr. Michael Owen, quoted in the farm journal *Successful Farming*, was on a recent U.S. National Academy of Sciences Committee that described glyphosate-resistant weeds as a major problem that deserves "national attention." See: NRC (2010). "The Impact of Genetically Engineered Crops on Farm Sustainability in the United States," National Research Council, National Academy of Sciences, 2010 (prepublication copy), p. 2-21.

Superweed Outbreak Triggers Arms Race

- Monsanto, Dow, DuPont, Bayer AG, BASF and Syngenta are spending hundreds of millions of dollars to develop **new** GM herbicide resistant crops

- "It will be a very significant opportunity" for chemical companies, says John Jachetta, a scientist at Dow Chemical's Dow AgroSciences and president of the Weed Science Society of America. **"It is a new era."** Wall St. Journal, 6/4/10

See: Kilman, S. (2010). "Superweed outbreak triggers arms race," *The Wall Street Journal*, June 4, 2010. http://www.gmwatch.org/latest-listing/1-news-items/12263-superweed-outbreak-triggers-arms-race

This article provides a good description of how glyphosate-resistant weeds fostered by Roundup Ready crop systems are driving the industry to invest hundreds of millions of dollars in the development of many new crops resistant to older, more toxic herbicides, like 2,4-D and dicamba. This is by far the biggest R&D focus of the biotechnology industry. In fact, there are 10 herbicide-resistant (HR) crops awaiting USDA's approval (as of January 2011), far more than any other category of GM crops. See http://www.aphis.usda.gov/biotechnology/not_reg.html. There are many other HR crops in the longer-term pipeline.

The idea is that these other herbicides will be used to kill glyphosate-resistant weeds, but there is already widespread concern and some preliminary evidence that these new HR crops will lead to rapid evolution of weeds with resistance to 2,4-D, dicamba, etc., possibly in combination with resistance to glyphosate and ALS inhibitors, creating the still more intractable problem of multiple herbicide-resistant weeds. See: Kruger, G.R. et al (2008). "Response and Survival of Rosette-Stage Horseweed (*Conyza canadensis*) after Exposure to 2,4-D," Weed Science 56: 748-752; Kruger, G.R. et al (2010). "Growth and Seed Production of Horseweed (*Conyza canadensis*) Populations after Exposure to Postemergence 2,4-D," Weed Science 58: 413-419.

The "New Era" of More Pesticides in Foods

Glyphosate Tolerance	Former tolerance (parts per million)	Tolerance today (ppm) (as of 9/15/09)
Soybeans	6.0	20.0
Corn, field, grain	1.0	5.0
Corn, field, forage	1.0	6.0
Cotton, gin byproducts	100	210
Canola seed	10	20
Sugar beets	0.2	10 to 25 (depending on plant part)
Aspirated grain fractions	200	310

The "New Era" of More

- Dow awaits USDA approval of corn and soybeans resistant to 2,4-D, part of the dioxin-laced, Vietnam War defoliant Agent Orange, a carcinogen and endocrine disruptor

  http://www.beyondpesticides.org/pesticides/factsheets/2,4-D.pdf

- Monsanto has soybeans resistant to dicamba, a chlorinated chemical cousin of 2,4-D linked to higher rates of colon cancer in farmers, and genotoxic in lab tests

  http://www.organic-center.org/science.hot.php?action=view&report_id=96

- "Penn State University weed scientist David Mortensen estimates that in three or four years, farmers' use of dicamba and 2,4-D will increase by **55.1 million pounds a year** because of resistance to Roundup."

  Roundup resistant weeds pose environmental threat, Associated Press, 6/21/10, http://www.google.com/hostednews/ap/article/ALeqM5jhIU9-B0h4pfKJVJDadwRUYkY_wgD9GFGSV02

For information on the toxicity of 2,4-D, see: http://www.beyondpesticides.org/pesticides/factsheets/2,4-D.pdf.

For more information on dicamba, see "Dicamba risk bibliography" link at http://www.organic-center.org/science.hot.php?action=view&report_id=96.

For the estimate by Dr. Dave Mortensen of increased use of dicamba and 2,4-D with introduction and adoption of soybeans resistant to them, see: http://www.usatoday.com/tech/science/environment/2010-06-21-roundup-weeds_N.htm. See also Dr. Mortensen's Congressional testimony, at: http://oversight.house.gov/index.php?option=com_content&view=article&id=921%3A07-28-2010-domestic-policy-qare-superweeds-an-outgrowth-of-usda-biotech-policy-part-iq&catid=18%3Asubcommittee-on-regulatory-affairs&Itemid=1

For testimony re: glyphosate-resistant weeds as an outgrowth of USDA biotechnology policy at a Congressional Oversight Committee hearing, see: http://www.centerforfoodsafety.org/2010/09/30/center-for-food-safety-testifies-at-congressional-oversight-hearing-on-'superweeds'-caused-by-biotech-crops/.

Another serious concern with GM crops resistant to dicamba, 2,4-D and other herbicides is spray drift or volatilization damaging neighbors' crops (dicamba is especially hazardous in this regard). See Congressional testimony of Steve Smith of Red Gold, an Indiana-based tomato processor, at: http://oversight.house.gov/index.php?option=com_content&view=article&id=984%3A09-30-2010-domestic-policy-are-superweeds-an-outgrowth-of-usda-biotech-policy-part-ii&catid=18%3Asubcommittee-on-regulatory-affairs&Itemid=1.

Defensive Adoption

- Some growers buy Roundup Ready crops even though they don't want the trait – to protect against spray drift, misapplication by neighbor
- Dicamba volatilizes after application, can drift long distances to damage neighbors' crops

Baldwin, F.L. (2010). "Herbicide drift damaging rice," *Delta Farm Press*, June 7, 2010. http://deltafarmpress.com/rice/herbicide-drift-damaging-rice-0607/

Ford L. Baldwin is the principal of *Practical Weed Consultants, LLC* of Arkansas. This interesting article explains how defensive adoption of Roundup Ready corn to protect against spray drift leads to more rapid evolution of glyphosate-resistant weeds. The author makes the same point with respect to herbicide-resistant Clearfield rice and the herbicide the rice is engineered to resist.

Excerpt:

"A lot of growers planted Roundup Ready corn in the beginning out of self defense. I looked at enough glyphosate drift on conventional corn to understand why. Most growers initially used conventional [i.e. non-glyphosate] herbicides in the Roundup Ready corn. Over time though the progression was to glyphosate-based programs and we lost a lot of the benefit of what could have been a great resistance management tool."

The "New Era" of Pesticide-Promoting

- 2,4-D
- ACCase inhibitor
- Asulam
- Dalapon
- Dicamba
- HPPD inhibitors
- Phenylurea
- Paraquat
- Phenmedipham
- Phenoxy acid (auxin)
- PDS inhibitors
- PPO inhibitors

Green et al (2007). "New multiple-herbicide crop resistance and formulation technology to augment the utility of glyphosate," *Pest Management Science* 64(4):332-9

Pesticide firms have found soil microbes with genes that confer resistance to all the herbicides listed in the slide above, and they merely need to be introduced into crops to generate herbicide-resistant crops. The microbes presumably evolved resistance to these herbicides through repeated exposure to them in the field. If engineered into crops, these microbial genes will facilitate application of much higher rates of these herbicides, meaning that consumers, farmers and the environment will suffer from greater exposure to toxic herbicides. For the table on which this list is based, see: Green et al (2007). "New multiple-herbicide crop resistance and formulation technology to augment the utility of glyphosate," *Pest Management Science* 64(4):332-9. The author of this article is Jerry Green, a DuPont scientist who has sketched out his company's vision of multiple herbicide-resistant crops to be used with pre-mix herbicide products containing some or all the herbicides to which the crop is resistant.

USDA has already approved DuPont-Pioneer's "Optimum GAT" soybeans and corn resistant to glyphosate and ALS inhibitor herbicides, though they are not yet on the market.

DuPont-Pioneer has a patent that describes its plans for engineering individual crops with resistance to two to over seven different types of herbicide. See: "Novel Glyphosate-N-Acetyltransferase (GAT) Genes," U.S. Patent Application Publication, Pub. No. US 2009/0011938 A1, January 8, 2009, paragraph 33.

Excerpt:

"In some embodiments, a composition of the invention (e.g. a plant) may comprise two, three, four, five, six, seven, or more traits which confer tolerance to at least one herbicide, so that a plant of the invention may be tolerant to at least two, three, four, five, six, or seven or more different types of herbicides."

This is not unusual. Other pesticide-seed-biotechnology firms have similar plans and patents.

The "New Era" of Biotechnology (= Pesticide + Seed)

Pesticide Co.	Seed Firms Acquired (partial)
MONSANTO	DeKalb, Agracetus, Asgrow, Seminis, Delta & Pine Land, Holden's Foundation Seeds.
DUPONT	Pioneer
SYNGENTA	Northrup King, Advanta, Funk Seed Intl, Rogers Bros.
BAYER	Aventis CropScience, Nunhems BV, AgrEvo, Plant Genetic
DOW	Mycogen

See for instance: Fernandez-Cornejo, J. (2004). "The Seed Industry in U.S. Agriculture: An Exploration of Data and Information on Crop Seed Markets, Regulation, Industry Structure, and Research and Development," Economic Research Service, U.S. Department of Agriculture. Agriculture Information Bulletin Number 786, January 2004. **http://www.ers.usda.gov/publications/aib786/aib786.pdf.**

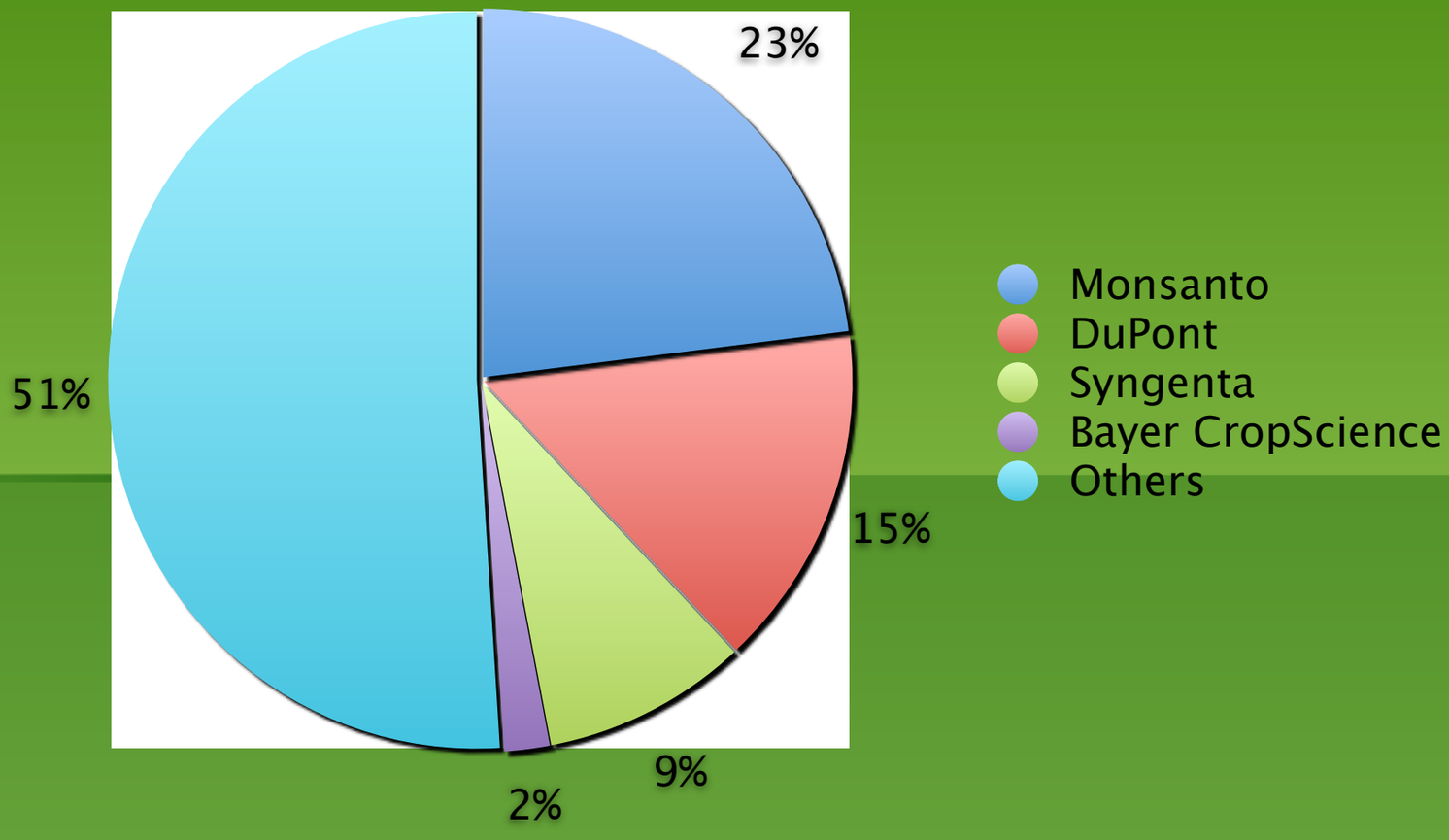
Concentration in the seed industry has led to less innovation and fewer seed varieties offered to farmers:

"Calculations for corn, soybeans, and cotton indicate that as the seed industry became more concentrated during the late 1990s, private research intensity dropped or slowed. … Those companies that survived seed industry consolidation appear to be sponsoring less research relative to the size of their individual markets than when more companies were involved. … fewer companies developing crops and marketing seeds may translate into fewer varieties offered."

From: Fernandez-Cornejo & Schimmelpfennig (2004). "Have Seed Industry Changes Affected Research Efforts?" USDA Economic Research Service, Amber Waves, Feb. 2004. http://www.ers.usda.gov/AmberWaves/February04/Features/HaveSeed.htm.

Control of Seed Supply

Share of Proprietary Seed Market: 2007



Company	2007 Seed Sales (millions $)	% Global Proprietary Seed Market
1. **Monsanto** (US)	$4,964	23%
2. **Dupont** (US)	$3,300	15%
3. **Syngenta** (Switzerland)	$2,018	9%
4. **Groupe Limagrain** (Fr)	$1,226	6%
5. **Land O' Lakes** (US)	$ 917	4%
6. **KWS AG** (Germany)	$ 702	3%
7. **Bayer CropSci** (Ger)	$ 524	2%
8. **Sakata** (Japan)	$ 396	<2%
9. **DLF-Trifolium** (Denm)	$ 391	<2%
10. **Takii** (Japan)	$ 347	<2%

Proprietary seed market 2007: $22 billion. Proprietary = brand-name seed subject to exclusive monopoly. Source: "Who Owns Nature? Corporate Power and the Final Frontier in the Commodification of Life," ETC Group, November 2008, p. 11. http://www.etcgroup.org/en/materials/publications.html?pub_id=707

Yield Drag with Roundup

- Analysis of 8,200 university soybean varietal trials in 1998 showed Roundup Ready soybeans yielded on average 5.3% less than conventional soybeans.

Benbrook, C (1999). "Evidence of the Magnitude and Consequences of Roundup Ready Soybean Yield Drag from University-Based Varietal Trials in 1998," AgBioTech InfoNet Tech. Paper No. 1, 7/13/99.

- "Two years of NU Institute of Agriculture and Natural Resources research showed Roundup Ready soybeans yield 6 percent less than their closest relatives ... This research showed that Roundup Ready soybeans' lower yields stem from the gene insertion process used to create the glyphosate-resistant seed. This scenario is called yield drag."

Elmore et al (2001). *Glyphosate-Resistant Soybean Cultivar Yields Compared with Sister Lines*, Agron J 2001 93: 408-412, quote above from the University of Nebraska press release announcing this study: "Research Shows Roundup Ready Soybeans Yield Less," May 16, 2000.

Benbrook, C (1999). "Evidence of the Magnitude and Consequences of Roundup Ready Soybean Yield Drag from University-Based Varietal Trials in 1998," AgBioTech InfoNet Tech. Paper No. 1, 7/13/99. http://www.mindfully.org/GE/RRS-Yield-Drag.htm

Elmore et al (2001). *Glyphosate-Resistant Soybean Cultivar Yields Compared with Sister Lines*, Agron J 2001 93: 408-412, quote above from the University of Nebraska press release announcing this study: "Research Shows Roundup Ready Soybeans Yield Less," May 16, 2000.

Elmore et al (2001) distinguish between "yield drag," which is the yield-reducing impact of the genetic modification process, and "yield lag," which is the yield deficit of a Roundup Ready variety related to the delay in breeding the RR trait into high-quality (high-yielding) germplasm (i.e. seed varieties). Yield drag was determined by comparing the yield performance of a Roundup Ready soybean variety and that of a conventional variety with virtually the same genetic background. Yield lag disappears over time, as the RR trait is bred into ever improved varieties.

Since the introduction of Roundup Ready (RR), breeding efforts have focused heavily on improving the yield of RR soybean varieties, with little or no breeding work devoted to conventional soybean varieties. Thus, RR soybeans today often outyield conventional varieties, but for reasons that have nothing to do with the RR trait and everything to do with conventional breeding.

Failure to Yield

- April 2009 study – "Failure to Yield" – by Union of Concerned Scientists (UCS)
- Analyzed peer-reviewed literature comparing yields of GE vs. conventional corn and soybeans
- No yield advantage for herbicide-tolerant corn or soybeans
- **Corn yield increases due mainly to conventional breeding**; just 0.2-0.3% yield increase/year from Bt insect-resistant trait in corn since introduction in 1996
- "If we are going to make headway in combating hunger due to overpopulation and climate change, we will need to increase crop yields. Traditional breeding outperforms genetic engineering hands down."

  Dr. Doug Gurian-Sherman, Senior Scientist, UCS

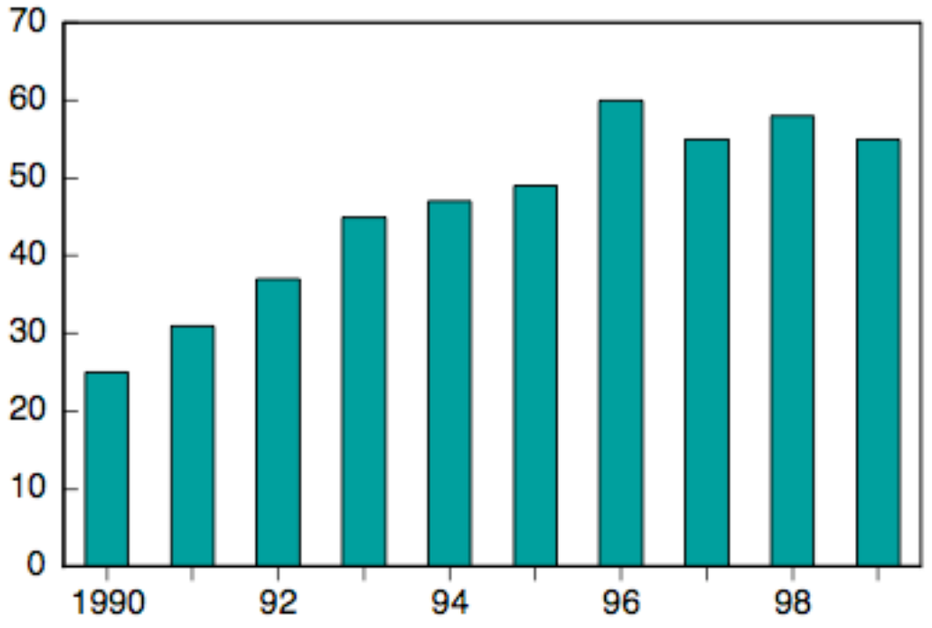
This study demonstrates that yield increases in corn and soybeans continue to come almost entirely from conventional breeding. GM herbicide-tolerance traits offer no yield advantage. Insect-resistance traits in corn have had very little impact on yield. The great majority of the yield increase in corn over the past years is attributable to conventional breeding.

See: Gurian-Sherman, D. (2009). "Failure to Yield: Evaluating the Performance of Genetically Engineered Crops," Union of Concerned Scientists, April 2009. http://www.ucsusa.org/food_and_agriculture/science_and_impacts/science/failure-to-yield.html.

Ready Ready does not reduce tillage

Figure 11

Use of conservation tillage - soybeans

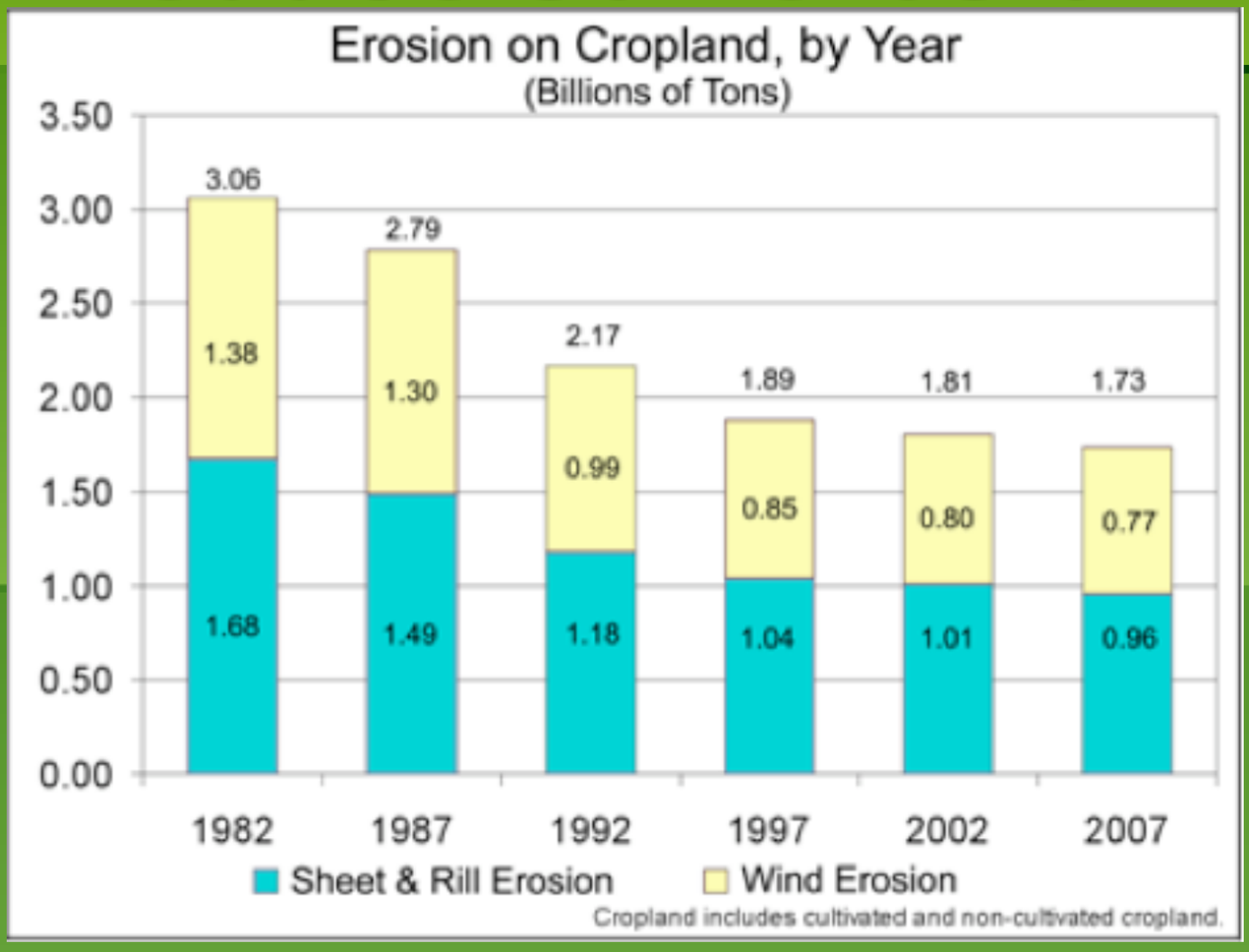


Source: Fernandez-Cornejo (2000) based on USDA data (USDA, 1997a updated from ARMS).

It has been claimed that adoption of Roundup Ready soybeans leads farmers to use no-till or conservation tillage practices. In fact, however, there is no such relationship. The chart above, from a USDA publication, shows that adoption of conservation tillage practices with soybeans rose substantially in the the early 1990s (it also rose in the 1980s) before Roundup Ready soybeans were introduced in 1996. In the three years after RR soybeans were introduced, the percentage of soybeans under conservation tillage remained relatively constant (even dropped a bit). Therefore, it is incorrect to say that Roundup Ready soybeans drive adoption of conservation tillage. Rather, farmers who first adopt conservation tillage practices are somewhat more likely to grow Roundup Ready soybeans.

See: Fernandez-Cornejo, J. & W. McBride (2002). "Adoption of Bioengineered Crops," Agricultural Economic Report No. 810, Economic Research Service, USDA, Figure 13, page 29. http://www.ers.usda.gov/publications/aer810/aer810.pdf.

Roundup Ready does not reduce soil erosion



It is often claimed that Roundup Ready crops lead to reduced soil erosion because they drive adoption of no-till or conservation tillage practices. The previous slide shows that this is not true in the 1996 to 1999 time period. The chart above shows that soil erosion in the U.S. declined dramatically from 1982 to 1997, also the years of large increases in the use of conservation tillage/no-till practices. But in the period when Roundup Ready crops were massively adopted in US agriculture (1997-2007), soil erosion declined very little. Soil erosion values in the chart above are based primarily on percentage of cropland under various tillage practices over time. Standard erosion rates for no-till, conservation tillage, and plowed land were used to calculate overall cropland erosion. This offers further evidence that Roundup Ready crops have not meaningfully increased the use of soil-conserving conservation tillage or reduced soil erosion, especially in comparison to the preceding 15 years.

See: NRCS (2010). "2007 National Resources Inventory: Soil Erosion on Cropland," National Resource Conservation Service, USDA, April 2010, p. 2. http://www.nrcs.usda.gov/technical/NRI/2007/nri07erosion.html.

Roundup Ready does not fight global warming

- This claim based largely on the false notion that RR crops lead to increased adoption of no-till methods
- Even if it were so, no-till does ***not*** sequeser more carbon, and may increase emissions of potent nitrogenous greenhouse gases

No-till does *not* sequester more carbon in the soil, as once believed:

Some of the carbon dioxide taken up from the air by plants is sequestered in root tissue or deposited by the roots as soil organic carbon (SOC). The more SOC, the less CO2, and the less global warming. Some early studies found that soil organic carbon levels were higher in no-till soils vs. plowed soils. However, these studies relied on very shallow soil samples of 30 cm. Recent literature reviews that included studies with deeper soil sampling have shown that while no-till soils often sequester more carbon in the top 30 cm, plowed soils usually have higher carbon levels at greater depths. The conclusion is that there is no difference in the soil organic carbon levels of tilled vs. no-till soils, and hence no global warming mitigation benefit from no-till. See: Baker, J.M et al (2007). "Tillage and soil carbon sequestration – What do we really know?" Agriculture, Ecosystems and Environment 118: 1-5. See: Lal, H.B.-C.R (2008). "No-tillage and soil-profile carbon sequestration: an on-farm assessment," *Soil Sci. Soc. Am. J.* 72: 693-701.

No-till may increase emissions of more potent nitrogenous greenhouse gases:

Recent research also shows that emissions of the much more potent nitrogen-based global warming gases (e.g. ammonia and nitrous oxide, the latter a global warming gas over 300 times more potent than CO_2) from fertilizer use can be higher on no-till vs. plowed soils. This is due to generally higher levels of volatilization of nitrogen-based fertilizers applied to no-till vs. plowed soils,* as well as greater saturation of no-till soils with water, which favors increased nitrous oxide emissions.+ Thus, the emerging scientific consensus is that no-till/conservation tillage does not reduce global warming gas emissions, and in some circumstances may even exacerbate global warming, in comparison to conventionally plowed fields.

* Al-Kanani, T., MacKenzie, A.F. (1992). "Effect of tillage practices and hay straw on ammonia volatilization from nitrogen fertilizer solution," *Can. J. Soil Sci.* 72:145-157.

+ Ball, B.C., Scott, A., Parker, J.P. (1999). "Field N2O, CO2, and CH4 fluxes in relation to tillage, compaction and soil quality in Scotland," *Soil Tillage Res*. 53:29-39.

For fuller discussion, see: CFS comments on USDA's environmental assessment of petition to deregulate DuPont-Pioneer's herbicide-tolerant corn Event 98140, Feb. 6, 2009, pp. 27-38. http://www.centerforfoodsafety.org/pubs/CFS%20comments%20on%20Pioneer%20HT%2098140%20corn%20EA_final_2_6_09-FINAL.pdf

Organic Beats No-Till

- 9-year study by USDA researchers compared 2 organic production systems to conventional no-till: corn, soybeans and wheat
- Organically farmed soils stored more carbon and nitrogen than conventional no-till soils
- Organic thus offers more global warming mitigation benefits than no-till

Over the long term, organic agriculture results in better soil than no-till, storing more carbon and nitrogen. USDA-ARS researchers conducted a 9-year study at the USDA experimental farm in Beltsville, MD to compare soil fertility and yields of corn, soybeans and wheat grown in either a standard no-till system, a living mulch no-till system, or a plow-based organic system. They found that even though the organic fields were tilled they contained more carbon and nitrogen at all depths (down to 30 cm) than the no-till plots. This was attributed to incorporation into the soil of both manure (organic fertilizer) and cover crops. Yields of corn and soybeans, but not wheat, were lower in the organic plots, though, because weeds were not adequately controlled by the particular organic methods they used. Further experiments showed that use of certain crop rotations in the organic system could control weeds and restore the lost yields, and that the stored nutrients in the organic soils were able to boost corn yields for subsequent crops relative to the soils that had been managed using no-till methods.

From: CFS comments on USDA's environmental assessment of petition to deregulate DuPont-Pioneer's herbicide-tolerant corn Event 98140, Feb. 6, 2009, pp. 27-38. http://www.centerforfoodsafety.org/pubs/CFS%20comments%20on%20Pioneer%20HT%2098140%20corn%20EA_final_2_6_09-FINAL.pdf

USDA study by: Teasdale, J.R., C.B. Coffman, and R.W. Mangum. 2007. Potential long-term benefits of no-tillage and organic cropping systems for grain production and soil improvement. Agron. J. 99:1297-1305.

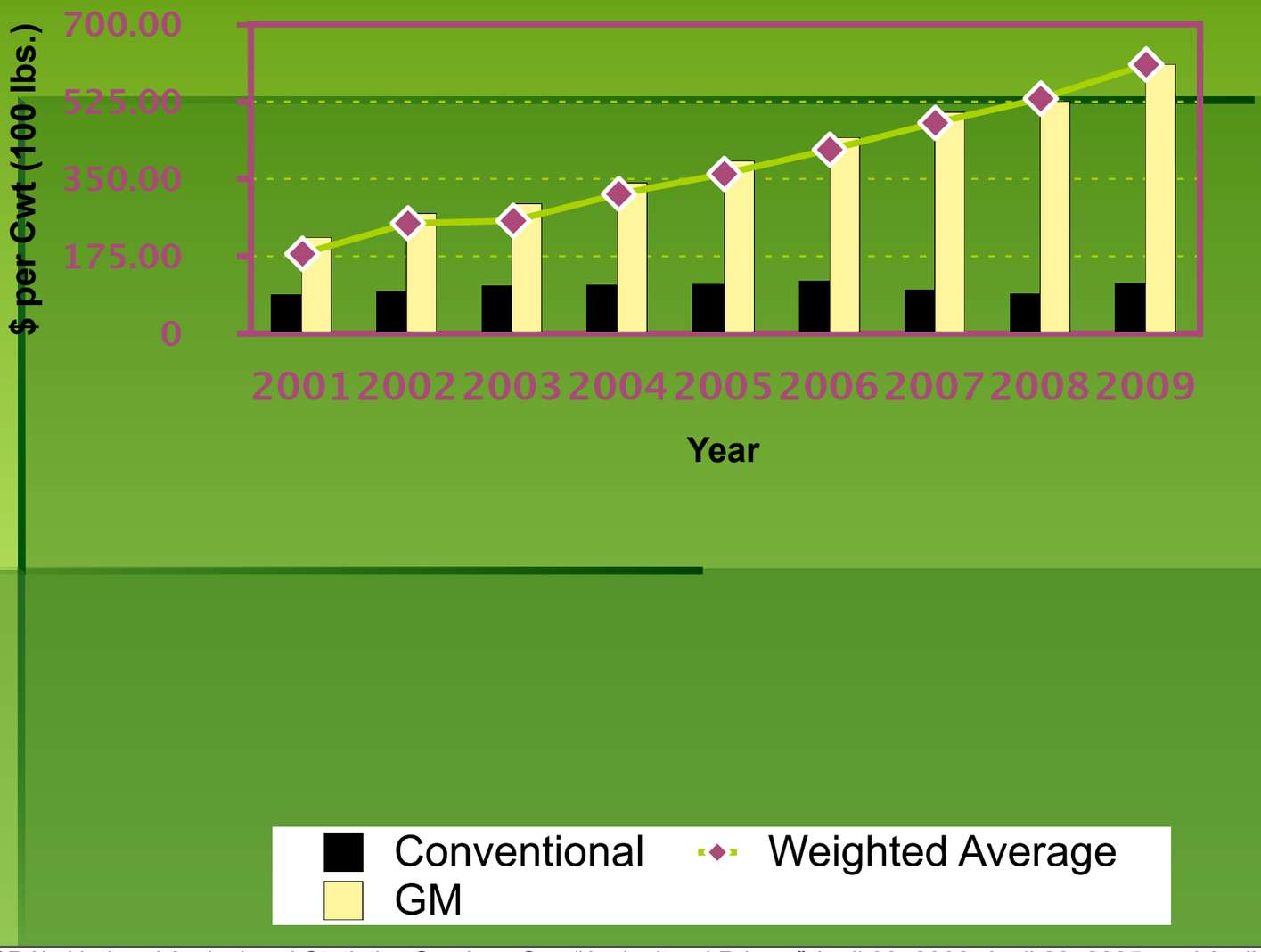
Concerns with GM Crops in Developing Countries

- Displace food production
- Sharply rising seed prices from “trait penetration”
- Withdrawal of conventional seeds
- Intellectual property rights (and wrongs)
- Affordable solutions ignored in favor of expensive GM crops

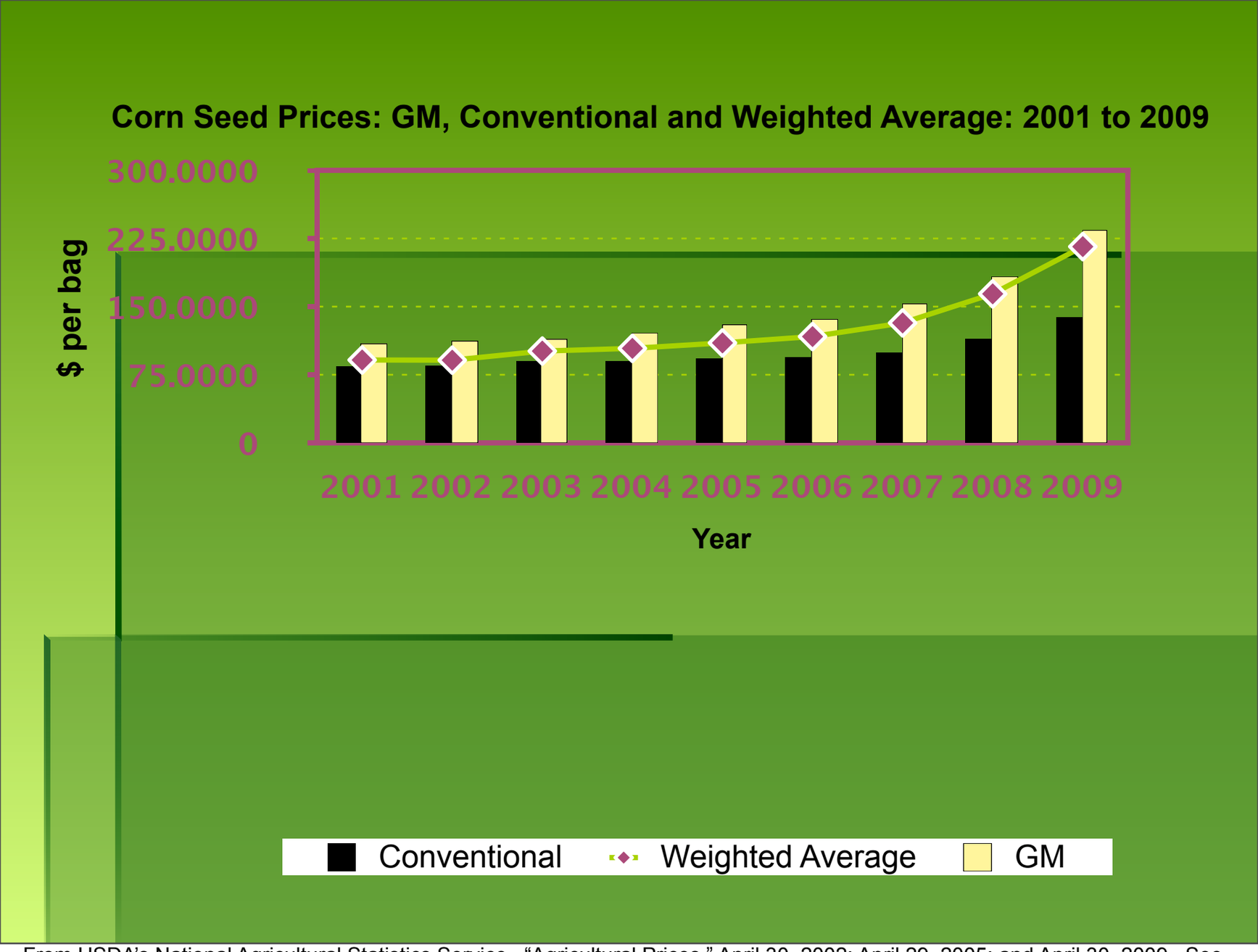
GM Crops in Global South

- ~ ¾ of GM crops grown in developing countries = Roundup Ready soybeans
- Soy monocultures growing in Argentina, Brazil, Paraguay, displace small farmers and food crops
- Soy sent to EU and other rich nations for use as animal feed, not for hungry people

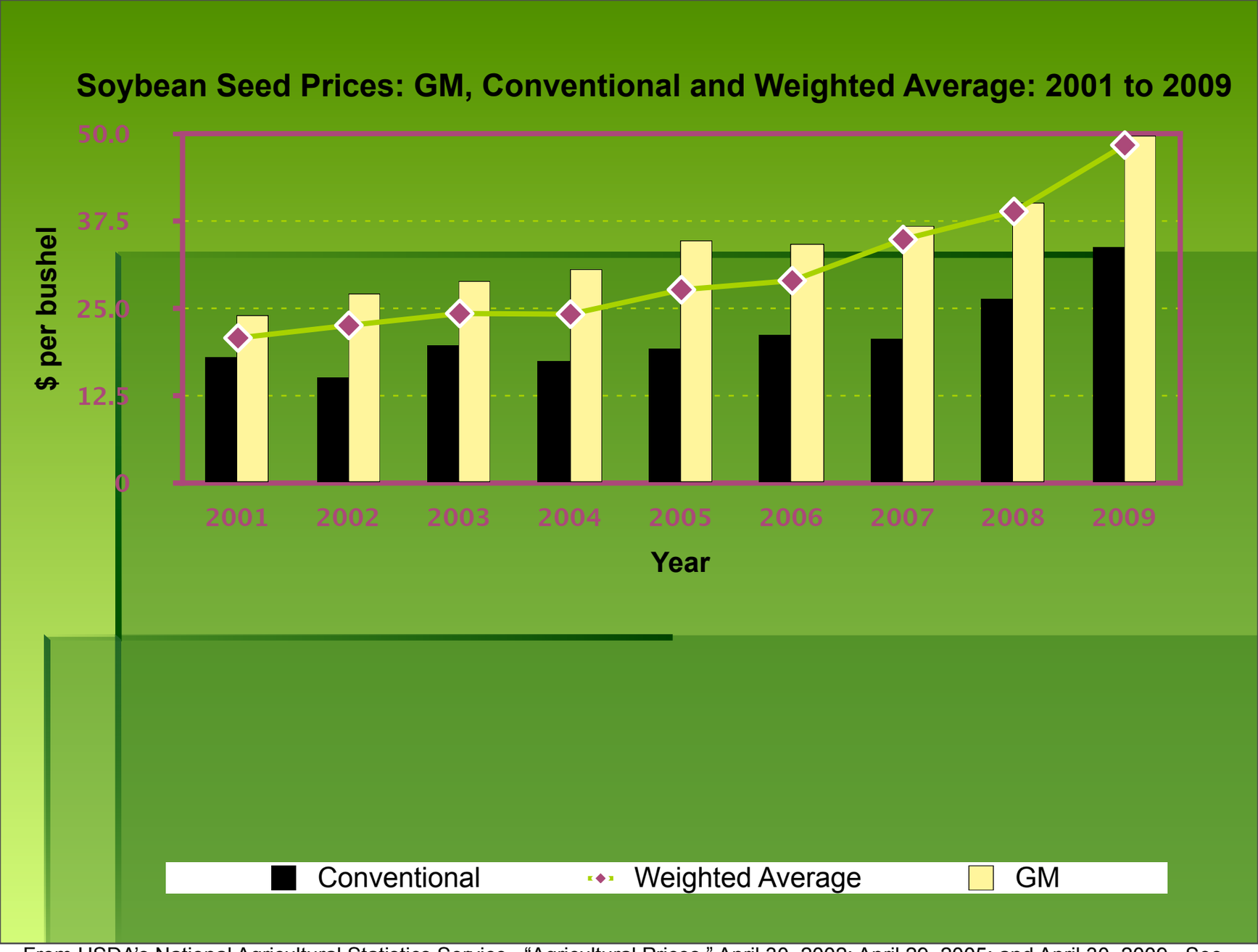
Cotton Seed Prices: GM, Conventional and Weighted Average: 2001 to 2009



From USDA's National Agricultural Statistics Service. See "Agricultural Prices," April 30, 2002; April 29, 2005; and April 30, 2009 (three separate documents with same name but different dates). Go to page that lists seed prices under the "Prices Paid" category. See appropriate links at: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002.



From USDA's National Agricultural Statistics Service. "Agricultural Prices," April 30, 2002; April 29, 2005; and April 30, 2009. See appropriate links at: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002.



From USDA's National Agricultural Statistics Service. "Agricultural Prices," April 30, 2002; April 29, 2005; and April 30, 2009. See appropriate links at: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002.

Bt Cotton in Asia

- In India, Bt cotton seed 3-4 times the price of conventional cotton seed
- Poor dryland cotton farmer borrows to pay for expensive Bt cotton seed
- If crop fails (e.g. poor monsoon), falls into debt to moneylenders, driving debt spiral
- In 2009, > 17,000 Indian farmers committed suicide, up 7% from 2008

1) Rs 550 per packet conv'l seed; 1800 Bt
2) Rs 400 per packet conv'l seed; 1850 Bt

1) As cited in notice issued to Monsanto and its Indian affiliates for taking undue advantage of its monopoly in Bt cotton seed by charging a royalty of Rs 1,250 for a 450 g packet of seed (Mitta, M. "Monsanto gets notice over 'exorbitant' royalty," Times of India, Jan. 29, 2006.

2) Kamdar, M. (2007). "Planet India: The Turbulent Rise of the Largest Democracy and the Future of Our World," pp. 154-155.

India's Monopolies and Restrictive Trade Practices Commission

Phasing out conventional

This is a page from Bayer CropScience's 2006 Fibermax Variety Guide, Bayer's cotton seed catalog. The cotton seed varieties circled in red (FM 832, FM 958 and FM 966) are conventional seeds, and at this time were "in limited supply," despite the fact that they were among Bayer's most popular seed varieties at the time. In contrast, Bayer offered a broad selection of genetically modified varieties (those with suffixes BR, B2R, LL, LLB2, etc.). Bayer is in the process here of phasing out popular conventional seed varieties in favor of more expensive and profitable GM cotton seed varieties. After Monsanto's acquisition of Delta and Pine Land (DPL), it phased out many of the DPL's conventional varieties for similar reasons. It has also become very difficult to find suitable cotton seed varieties that have ONLY the Bt insect resistance trait (the same is true with corn seed). Now nearly all cotton and corn seed varieties come with both Bt and herbicide-resistance traits. The result is fewer seed choices for farmers. For more on this, see:

Freese, B. (2007). "Cotton Concentration Report: An Assessment of Monsanto's Proposed Acquisition of Delta and Pine Land," International Center for Technology Assessment/Center for Food Safety, Feb. 2007. http://www.centerforfoodsafety.org/pubs/CFS-CTA%20Monsanto-DPL%20Merger%20Report%20Public%20Release%20-%20Final%20_2_.pdf.

Demand for Conventional Soybean Seed Outstrips Supply

- Increased demand for conventional soybeans since 2007 in Missouri, Ohio, Mississippi and Kansas – in some cases outstripping supply

- Driven by:
  - Rising price of Roundup Ready seed
  - Roundup-resistant weeds
  - Price premium for non-GM soybeans
  - Legal to save/replant, additional cost savings

On increased demand for and limited supplies of conventional soybeans, see:

Jones, T. (2008). "Conventional soybeans offer high yields at lower cost," University of Missouri, Sept. 8, 2008. http://agebb.missouri.edu/news/ext/showall.asp?story_num=4547&iln=49;

Medders, H. (2009). Soybean demand may rise in conventional state markets," University of Arkansas, Division of Agriculture, March 20, 2009, http://www.stuttgartdailyleader.com/homepage/x599206227/Soybean-demand-may-rise-in-conventional-state-markets

Bennett, D. (2009). "More conventional soybean acres?" Delta Farm Press, Feb. 10, 2009, http://deltafarmpress.com/soybeans/conventional-acres-0210/.

Bennett, D. (2009). "Conventional soybeans draw interest," Delta Farm Press, April 3, 2009, http://deltafarmpress.com/soybeans/conventional-soybeans-0403/.

Roseboro, K. (2008). "Finding non-GMO soybean seed becoming more difficult: Fewer breeding programs for non-GMO soybeans are reducing supplies despite strong demand," The Organic and Non-GMO Report, July 2008. http://www.non-gmoreport.com/articles/jul08/non-gmo_soybean_seed.php.

Pollack, C. (2009). "Interest in Non-Genetically Modified Soybeans Growing," Ohio State University Extension, April 3, 2009, http://extension.osu.edu/~news/story.php?id=5099.

Intellectual Property Rights (and Wrongs)

- Goal of seed industry is to eliminate millennia-old practice of farmer seed-saving to increase seed sales
- Two mechanisms:
  - Legal: patent & contract (technology use agreement)
  - Biological: seed-sterility (Terminator)

Monsanto's Prosecution of U.S. Farmers

- 75 employees, $10 million per year devoted to investigating and suing U.S. farmers for alleged patent infringement
- Monsanto hires private investigators (McDowell & Associates of St. Louis) and prominent U.S. law firms
- Investigates roughly 500 farmers/year
- Source: "Monsanto vs. U.S. Farmers," Center for Food Safety, 2005 & 2007 update: http://www.centerforfoodsafety.org/Monsantovsusfarmersreport.cfm

Source for this and following slides: "Monsanto vs. U.S. Farmers," Center for Food Safety, 2005. See also 2007 update. http://www.centerforfoodsafety.org/Monsantovsusfarmersreport.cfm.

Lawsuits Against Farmers

- Monsanto has initiated 112 lawsuits involving 372 farmers and 49 small businesses/farm companies since 1997
- 18 cases are ongoing as of October 26, 2007
- At least 25 of these farmers have never signed a Technology Agreement

Settlements

Highest: $3,052.800

Lowest: $5,595

Median: $75,000

Average: $412,259

Total recorded judgments: $21,583,432

"Monsanto vs. U.S. Farmers," Center for Food Safety, 2005. See also 2007 update. http://www.centerforfoodsafety.org/Monsantovsusfarmersreport.cfm.

Note: Despite the photo, nearly all cases involve Roundup Ready soybeans, not corn. Even just 20-30 years ago, saving soybeans was common practice among American farmers. Monsanto's aggressive prosecution and persecution of U.S. farmers and seed cleaners has dramatically reduced soybean seed saving and reduced the number of active seed cleaners.

Coerced Out-of-Court Settlements

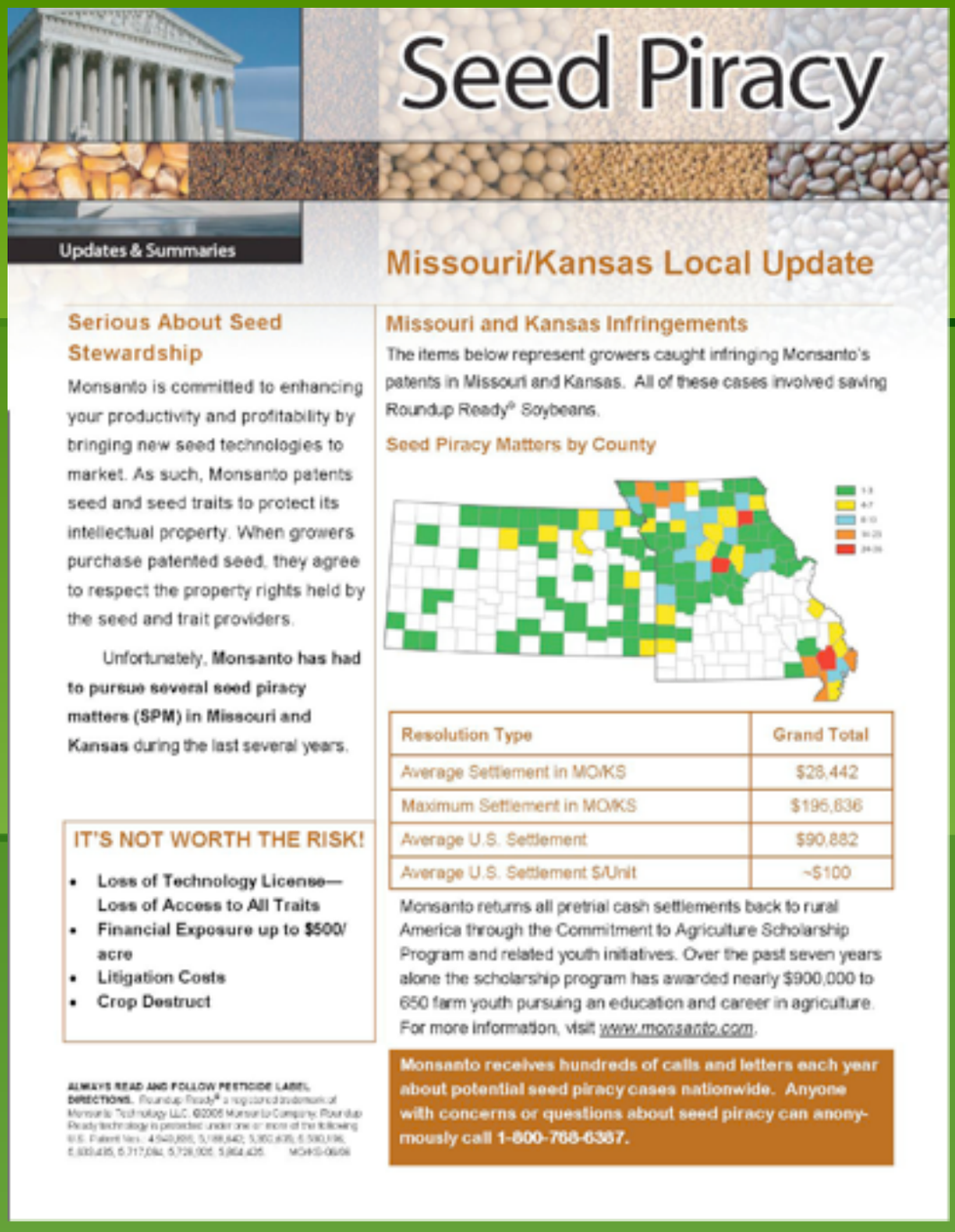
- Monsanto or hired investigators threaten to sue farmer and start a lengthy and expensive lawsuit unless the farmer agrees to settle out-of-court
- "…the vast majority of cases filed by Monsanto against farmers have been settled before any extensive litigation took place." District Court Judge Catherine Perry, in Monsanto Co. v. McFarling, 2005
- Settlements often include provisions:

  1) Confidential = farmer subject to heavy fines if he/she speaks

  2) Allow Monsanto to test the farmer's crops for 5 years;

  3) Prohibit or force purchase of Monsanto's products
- Two documentaries highly recommended:
  - "The World According to Monsanto"
  - "Food, Inc.," by the producers of An Inconvenient Truth

See: Center for Food Safety, 2005. See also 2007 update. http://www.centerforfoodsafety.org/Monsantovsusfarmersreport.cfm.



Seed Piracy

Updates & Summaries

Missouri/Kansas Local Update

Serious About Seed Stewardship

Monsanto is committed to enhancing your productivity and profitability by bringing new seed technologies to market. As such, Monsanto patents seed and seed traits to protect its intellectual property. When growers purchase patented seed, they agree to respect the property rights held by the seed and trait providers.

Unfortunately, **Monsanto has had to pursue several seed piracy matters (SPM) in Missouri and Kansas** during the last several years.

IT'S NOT WORTH THE RISK!

- **Loss of Technology License—Loss of Access to All Traits**
- **Financial Exposure up to $500/acre**
- **Litigation Costs**
- **Crop Destruct**

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. Roundup Ready® is a registered trademark of Monsanto Technology LLC. ©2006 Monsanto Company. Roundup Ready technology is protected under one or more of the following U.S. Patent Nos.: 4,940,835; 5,188,642; 5,352,605; 5,530,196; 5,633,435; 5,717,084; 5,728,925; 5,804,425. MO4KS-0606

Missouri and Kansas Infringements

The items below represent growers caught infringing Monsanto's patents in Missouri and Kansas. All of these cases involved saving Roundup Ready® Soybeans.

Seed Piracy Matters by County

Resolution Type	Grand Total
Average Settlement in MO/KS	$28,442
Maximum Settlement in MO/KS	$195,636
Average U.S. Settlement	$90,882
Average U.S. Settlement $/Unit	~$100

Monsanto returns all pretrial cash settlements back to rural America through the Commitment to Agriculture Scholarship Program and related youth initiatives. Over the past seven years alone the scholarship program has awarded nearly $900,000 to 650 farm youth pursuing an education and career in agriculture. For more information, visit www.monsanto.com.

Monsanto receives hundreds of calls and letters each year about potential seed piracy cases nationwide. Anyone with concerns or questions about seed piracy can anonymously call 1-800-768-6387.

This is a document CFS found on Monsanto's website in 2006. Monsanto brags about all the farmers they have prosecuted for the new "crime" of saving seed, and all the money they have collected from these farmers. The purpose appears to be to scare other farmers away from seed-saving, and so increase sales. Documents no longer found on Monsanto's website.

CFS believes Monsanto is the "seed pirate," not farmers.

For details, see: http://www.centerforfoodsafety.org/pubs/Monsanto%20November%202007%20update.pdf.

Estimates of Coerced Settlements

- Based on figures found in Monsanto's "Seed Piracy" updates for 19 states (downloaded summer 2006)
- Estimate 2,391 to 4,531 "seed piracy matters" settled
- Estimate that farmers paid Monsanto somewhere between $85.7 to $160.6 million

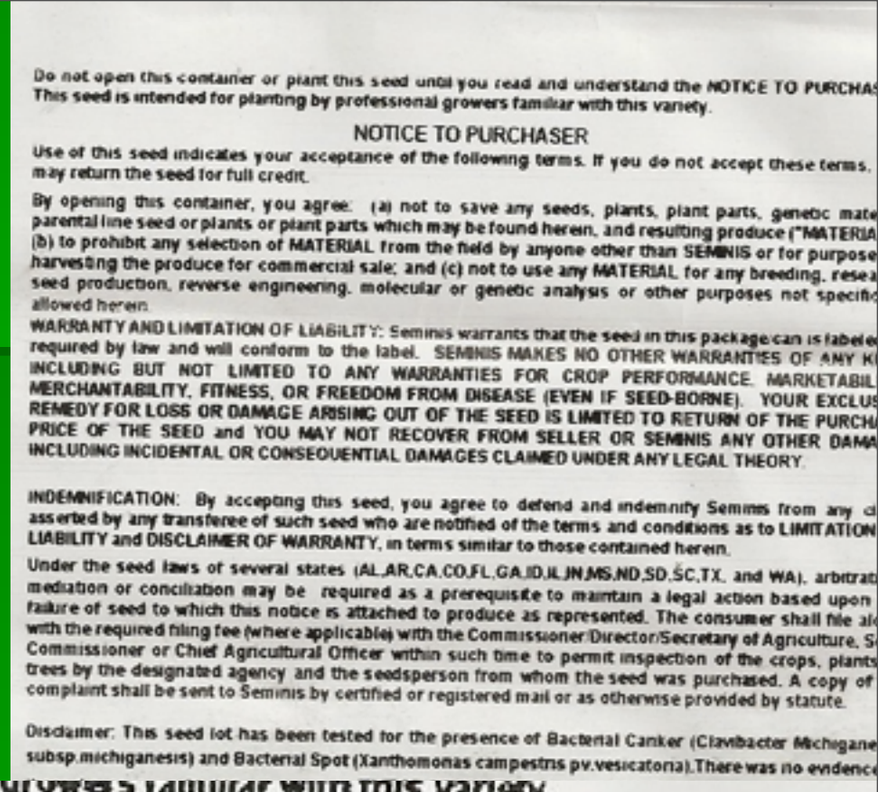
For details, see: http://www.centerforfoodsafety.org/pubs/Monsanto%20November%202007%20update.pdf.

Investigation Tactics

According to farmers who have been investigated, Monsanto's private investigators:

- ***Trespass*** on farmers' property to take photos or samples
- ***Adopt disguises*** to win farmers' trust (e.g. pretend to be farmers or land surveyors)
- Issue ***threats,*** become ***physically aggressive***
- Produce ***false or fabricated evidence***
- ***Encourage farmers to "rat" on neighbors via hotline –*** breeding suspicion, distrust in rural America

See: "Monsanto vs. U.S. Farmers," Center for Food Safety, 2005. See also 2007 update. http://www.centerforfoodsafety.org/Monsantovsusfarmersreport.cfm.



Do not open this container or plant this seed until you read and understand the NOTICE TO PURCHAS
This seed is intended for planting by professional growers familiar with this variety.

NOTICE TO PURCHASER

Use of this seed indicates your acceptance of the following terms. If you do not accept these terms, may return the seed for full credit.

By opening this container, you agree: (a) not to save any seeds, plants, plant parts, genetic mate parental line seed or plants or plant parts which may be found herein, and resulting produce ("MATERIA (b) to prohibit any selection of MATERIAL from the field by anyone other than SEMINIS or for purpose harvesting the produce for commercial sale; and (c) not to use any MATERIAL for any breeding, resea seed production, reverse engineering, molecular or genetic analysis or other purposes not specific allowed herein.

WARRANTY AND LIMITATION OF LIABILITY: Seminis warrants that the seed in this package/can is labele required by law and will conform to the label. SEMINIS MAKES NO OTHER WARRANTIES OF ANY KI INCLUDING BUT NOT LIMITED TO ANY WARRANTIES FOR CROP PERFORMANCE, MARKETABIL MERCHANTABILITY, FITNESS, OR FREEDOM FROM DISEASE (EVEN IF SEED-BORNE). YOUR EXCLUS REMEDY FOR LOSS OR DAMAGE ARISING OUT OF THE SEED IS LIMITED TO RETURN OF THE PURCHA PRICE OF THE SEED and YOU MAY NOT RECOVER FROM SELLER OR SEMINIS ANY OTHER DAMA INCLUDING INCIDENTAL OR CONSEQUENTIAL DAMAGES CLAIMED UNDER ANY LEGAL THEORY.

INDEMNIFICATION: By accepting this seed, you agree to defend and indemnify Seminis from any cl asserted by any transferee of such seed who are notified of the terms and conditions as to LIMITATION LIABILITY and DISCLAIMER OF WARRANTY, in terms similar to those contained herein.

Under the seed laws of several states (AL,AR,CA,CO,FL,GA,ID,IL,IN,MS,ND,SD,SC,TX, and WA), arbitrati mediation or conciliation may be required as a prerequisite to maintain a legal action based upon failure of seed to which this notice is attached to produce as represented. The consumer shall file al with the required filing fee (where applicable) with the Commissioner/Director/Secretary of Agriculture, S Commissioner or Chief Agricultural Officer within such time to permit inspection of the crops, plants trees by the designated agency and the seedsperson from whom the seed was purchased. A copy of complaint shall be sent to Seminis by certified or registered mail or as otherwise provided by statute.

Disclaimer: This seed lot has been tested for the presence of Bacterial Canker (Clavibacter Michigane subsp.michiganensis) and Bacterial Spot (Xanthomonas campestris pv.vesicatoria).There was no evidence

planting by professional growers familiar with this variety.

NOTICE TO PURCHASER

Use of this seed indicates your acceptance of the following terms. If you do not accept these terms may return the seed for full credit.

By opening this container, you agree: (a) not to save any seeds, plants, plant parts, genetic mat parental line seed or plants or plant parts which may be found herein, and resulting produce ("MATERI (b) to prohibit any selection of MATERIAL from the field by anyone other than SEMINIS or for purpos harvesting the produce for commercial sale; and (c) not to use any MATERIAL for any breeding, rese seed production, reverse engineering, molecular or genetic analysis or other purposes not specif allowed herein.

WARRANTY AND LIMITATION OF LIABILITY: Seminis warrants that the seed in this package/can is label

Monsanto bought Seminis, the world's biggest vegetable seed firm, in 2005. A colleague of mine recently sent me these photos of a Seminis tomato seed bag, which has language warning the grower "not to safe any seeds, plants, plant parts, genetic material, parental line seed or plants or plant parts which may be found herein…."

Though we are not aware of any lawsuits by Monsanto against vegetable growers, this "Notice to Purchaser" may indicate that Monsanto is moving in this direction.

Terminator

- Genetic modification to make harvested seeds sterile, and thereby increase seed sales by making seed-saving impossible
- USDA, Monsanto and other companies hold patents on Terminator technology
- "The agricultural seed industry must disavow the use of terminator technology to produce seed sterility."
  - Gordon Conway, former head of Rockefeller Foundation, 6/24/99
- Not currently implemented

For a description of how one form of Terminator technology works, see:
UCS (1998). "Biobit – Terminator Technology," The Gene Exchange, Fall/Winter 1998, Union of Concerned Scientists. http://go.ucsusa.org/publications/gene_exchange.cfm?publicationID=267

For an account of Terminator's purpose, to end the practice of seed saving and thereby increase seed sales, see:
Shand, H. (1999). "Avalanche of Public Opposition to Monsanto's Suicide Seeds," *Synthesis/Regeneration*, Spring 1999. http://www.greens.org/s-r/19/19-03.html.

For a good 2003 update on the status of Terminator technology, see:
ETC (2003). "Terminator Technology – Five Years Later," ETC Group Communiqué, May/June 2003. http://www.cbdcprogram.org/final/issues/termcom79eng.pdf.

For Gordon Conway's demand that Monsanto and seed industry give up Terminator technology, see:
Conway, G. (1999). "The Rockefeller Foundation and Plant Biotechnology," Address to the Board of Directors of Monsanto, June 24, 1999. http://www.biotech-info.net/gordon_conway.html

For Monsanto's waffling on its "pledge" not to develop Terminator technology, see:
http://www.etcgroup.org/upload/publication/25/01/monsantocorrespond.pdf

First the Seed

- "It is miserable for a farmer to be obliged to buy his Seeds; to exchange Seeds may, in some cases, be useful; but to buy them after the first year is disreputable."

  - George Washington, in letter to farm manager William Pearce, November 16, 1794. http://www.questia.com/PM.qst?a=o&docId=100594683

America's first president, George Washington, was also a farmer. He regarded seed-saving as a virtuous activity that all farmers should practice, while he considered those farmers who did NOT save seed as being lazy and disreputable. In today's world, the indepedence, thrift, and spirit of free enterprise implicit in the practice of seed-saving are being denied to ever more farmers, as the supply of quality, unpatented germplasm shrinks.

About three quarters of developing country farmers rely on saved seed (see Shand, H. (1999), op. cit., from previous slide). However, the practice is also common in developed countries, or was until recently. As recently as 1982 in the U.S., 45% of soybean acreage, 50% of cotton acreage and 90% of wheat acreage, were planted with saved seeds. By 1997, just 15 years later, these percentages had declined to 19% (soybeans), 22% (cotton) and 63% (wheat). See: Fernandez-Cornejo, J. (2004). "The Seed Industry in U.S. Agriculture: An Exploration of Data and Information on Crop Seed Markets, Regulation, Industry Structure, and Research and Development," Economic Research Service, U.S. Department of Agriculture. AIB No. 786, January 2004; Tables 4 and 5, p. 10. http://www.ers.usda.gov/publications/aib786/aib786.pdf.

Seed saving thus remains common in wheat, for which there is no GM variety, but has practically disappeared in soybeans and cotton, where GM varieties are predominant. Monsanto's investigations have often targeted soybean seed cleaners, who clean farmers' saved (soybean) seed to prepare it for replanting. Seed cleaners put out of business by Monsanto are no longer able to provide this valuable service to farmers who want to save and replant seeds. See the documentary Food, Inc., for the case of seed cleaner Moe Parr.

Real Solutions

- UN-World Bank-sponsored International Assessment of Agricultural Knowledge, Science and Technology for Development (IAAASTD)
- 400 development experts, 3 years:
  - Revitalize public sector ag'l research
  - Small farmer-oriented, low-input agroecology
  - Reform unfair trade-related rules
  - "Business as usual is no longer an option" – Bob Watson, IAASTD chair

Agroecology Works

- 114 organic & near-organic agricultural projects in Africa involving 1.9 million farmers achieved average crop yield increase of 116%
  - Poverty Eradication Project through Environmentally Sustainable Technologies (PEEST) in Uganda: 10,000 farmers
  - Organic cashews & vegetables in Tanzania (480 farmers)
  - Mount Kenya Organic Farm: organic vegetables; organic borage for export

Hine, R. & Pretty, J. (2008). "Organic Agriculture and Food Security in Africa," UNEP-UNCTAD

System of Rice Intensification

- Water-saving alternative to paddy cultivation
- Transplant young rice seedlings, widely spaced to allow for healthy root development
- No continuous flooding, saves water
- Weed w/ rotating hoe; amend soil w/ compost
- Raise yields 30-100% or more w/o new seeds, chemical fertilizers or pesticides
- Adopted by est'ed 1 million farmers in 28 countries: India, China, Indonesia, Cambodia, Vietnam
  - Uphoff, N. (2007). "Agroecological Alternatives: Capitalising on Existing Genetic Potentials," Journal of Development Studies 43(1): 218-36.

Compare proposed use of herbicide-tolerant rice for direct-seeding rice in India, center of origin of rice. Poses high risk of herbicide-resistant weed populations, pesticide treadmill

Push-Pull Maize

- Benefiting 15,000 farmers in Kenya, Uganda, Tanzania
- Intercrop corn with leguminous fodder plant (*Desmodium*) that repels stemborer; plant napier grass (attracts pest) on edge
- Enriches soil thru nitrogen fixation
- *Desmodium* also reduces infestation of fields with parasitic weed (*Striga*)
- Fodder used for dairy cows for milk and sale
- Improves nutritional status and income

- Khan, Z.R. et al (2008). "On-farm evaluation of the 'push-pull' technology for the control of stemborers and striga weed on maize in western Kenya," Field Crops Research 106 (2008): 224-233.

See: "47 Portraits of Sustainable Agriculture Projects and Initiatives," by Dr. Jules Pretty, University of Essex, Centre for Environment and Society, www2.essex.ac.uk/ces/researchprogrammes/safew47casessusag.htm. No. 6 under Africa.

See also: "Push-and-Pull: An Innovative and Low-tech Solution to Control Stemborers in Africa," Part 1 of *Genetic Engineering versus Organic Farming – The Fact and the Fiction,* by Florence Koechlin, International Federation of Organic Agriculture Movements (IFOAM), IFOAM Brochure 2002, http://www.blauen-institut.ch/Tx/tT/ttGenEngOrgFarm.html.

Cassava & the Mealybug

- Cassava (staple crop of 200 million Africans) threatened by mealybug
- Introduction of parasitic wasp hugely successful
- Saved millions of African lives at low cost
- Dr. Hans Herren of International Centre of Insect Physiology and Ecology (Nairobi) won World Food Prize in 1995

Dr. Hans Rudolf Herren … is one of the most outstanding crop protection scientists in the world. … In 1995, he was named World Food Prize Laureate … Herren was awarded the prize for his work on controlling the cassava mealybug in Africa. Cassava is a staple root crop for more than 200 million African people. An introduced pest, the cassava mealybug threatened to destroy this important food crop, creating a food emergency across the continent. … Herren developed and implemented, with a team of 30 scientists, one of the world's largest biological control programs. The cassava mealybug was identified and then found in South America …. Its natural enemies were quarantined, studied, and the most promising reared in mass numbers. The natural enemies were then released by a novel aerial insect release system, fitted into leased aircraft and flown across Africa to reach the most remote sites. Thirty countries eventually benefited from this control program. Today, cassava mealybug and its natural enemies coexist in low-level equilibrium across Africa, ensuring lasting biological control of this pest without further inputs.

Excerpted from biography of Dr. Herren at: University of Florida, Institute of Food and Agricultural Sciences. http://yorklecture.ifas.ufl.edu/Herren.htm

February 22, 2003.

Is Biotech Draining Funds from More Effective Solutions?

"Today, I probably would not get the money for such a big programme. Today, all funds go into biotechnology and genetic engineering. The genetic people would try to construct a cassava that is resistant against the mealy-bug. Biological pest control, as we do it here at ICIPE, is not as spectacular, not as sexy. I see a big problem here."

Dr. Hans Herren

As quoted in: "Push-and-Pull: An Innovative and Low-tech Solution to Control Stemborers in Africa," Part 1 of *Genetic Engineering versus Organic Farming – The Fact and the Fiction,* by Florence Koechlin, International Federation of Organic Agriculture Movements (IFOAM), IFOAM Brochure 2002, http://www.blauen-institut.ch/Tx/tT/ttGenEngOrgFarm.html.

The "big programme" referred to in the first quote is Herren's hugely successful biological control of cassava mealybug with a parasitic wasp.

Conclusions

- Biotechnology = Pesticides + Seeds:
  - Toxic spiral of resistant weeds and more pesticide use
- GM crops do not increase yield or fight global warming
- GM crops not a solution for developing countries: displace food, expensive seeds, outlaw seed-saving, reduce self-reliance
- Agroecology offers more cost-effective solutions w/o patents, expensive seeds, or problematic pesticides

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