Genetically modified foods and sustainable diets: harmful or helpful?

Sustainable Diet and Food Security
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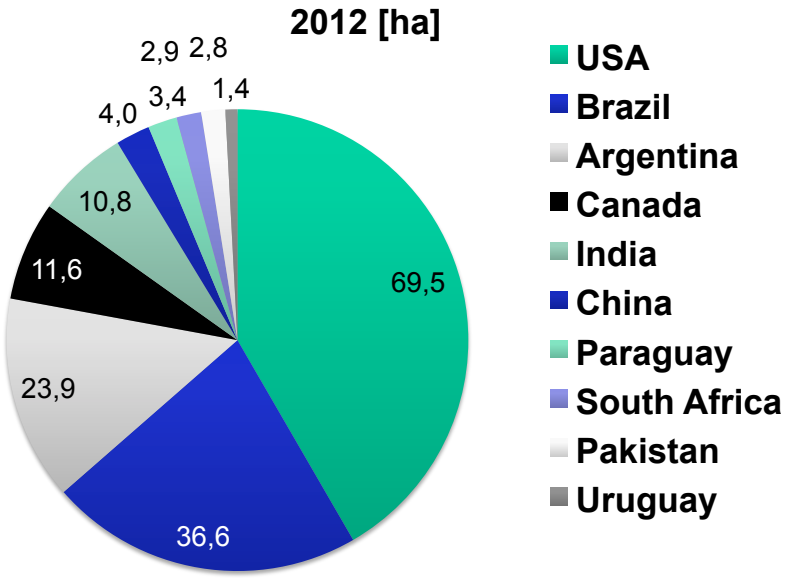
Content

- State of GM food production worldwide
- Failure to produce "real" food
- GM breeding's (too) simple paradigm
- Turning the picture with new GM plants?
- Non-GM breeding announcements in 2013
- Current approaches towards GMO risk assessment
- 2013: EU adopts first science-based GMO risk assessment

GM Crop Agriculture 2012



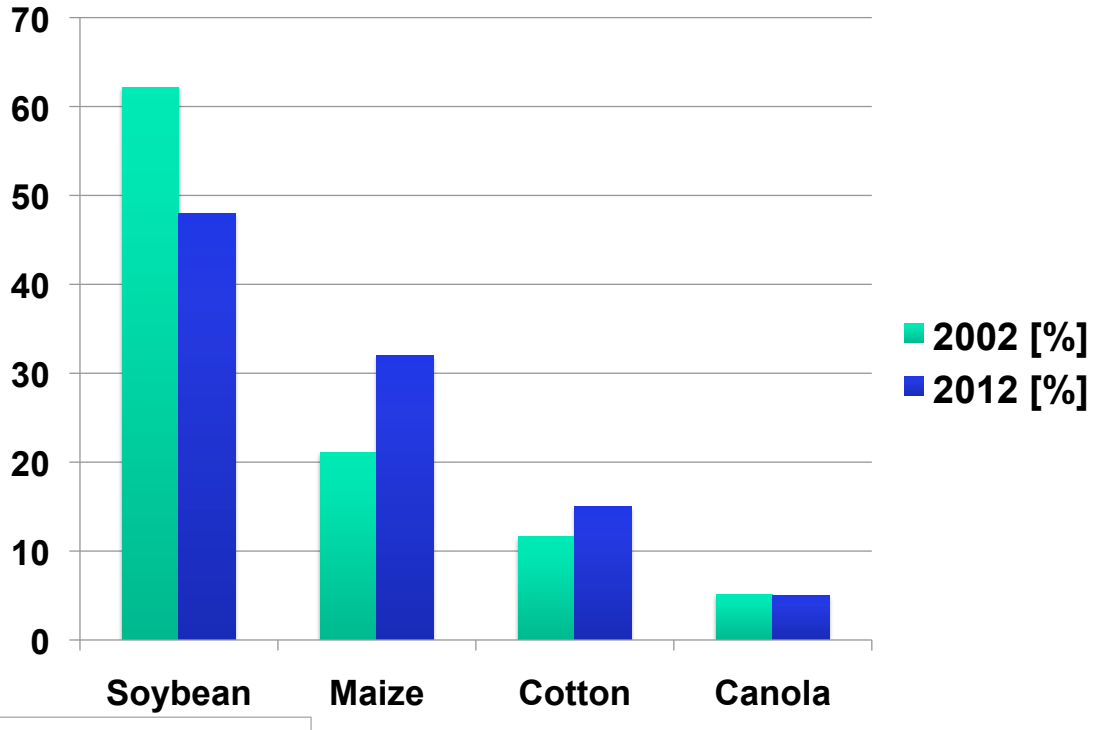
170,3 mill ha (12% of arable land)

17,3 mill farmers (1,3% of EAPA)

98,0% acreage in 10 countries

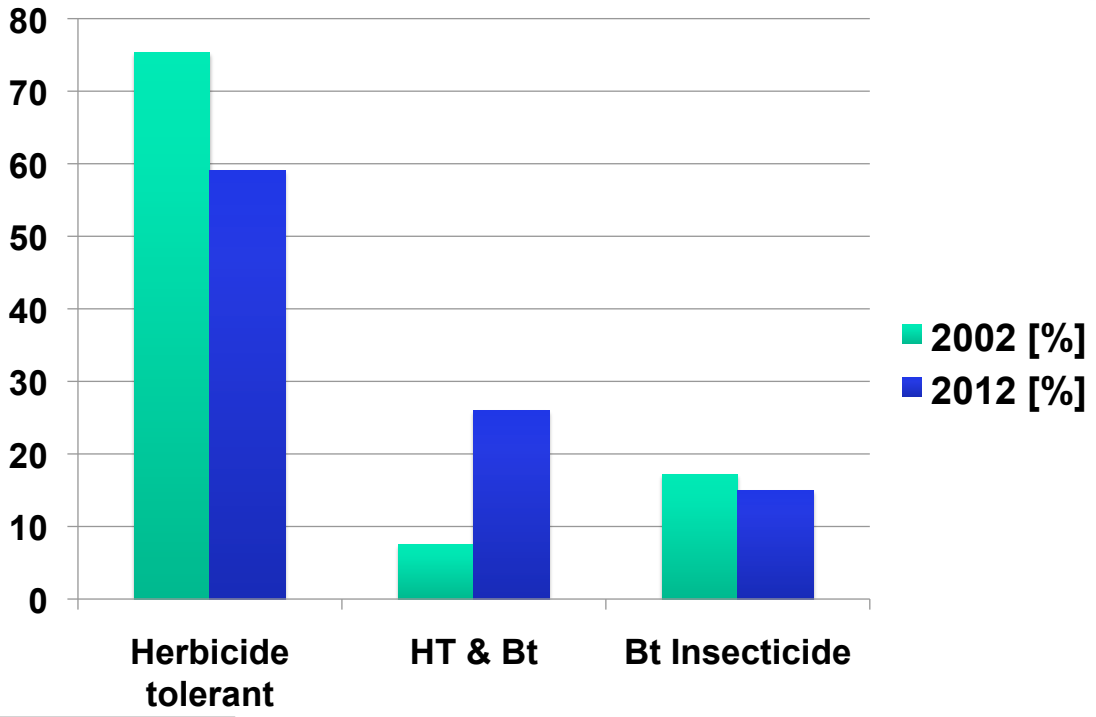
Source: based on ISAAA 2013, FAO 2013

GM Crops 2002 / 2012



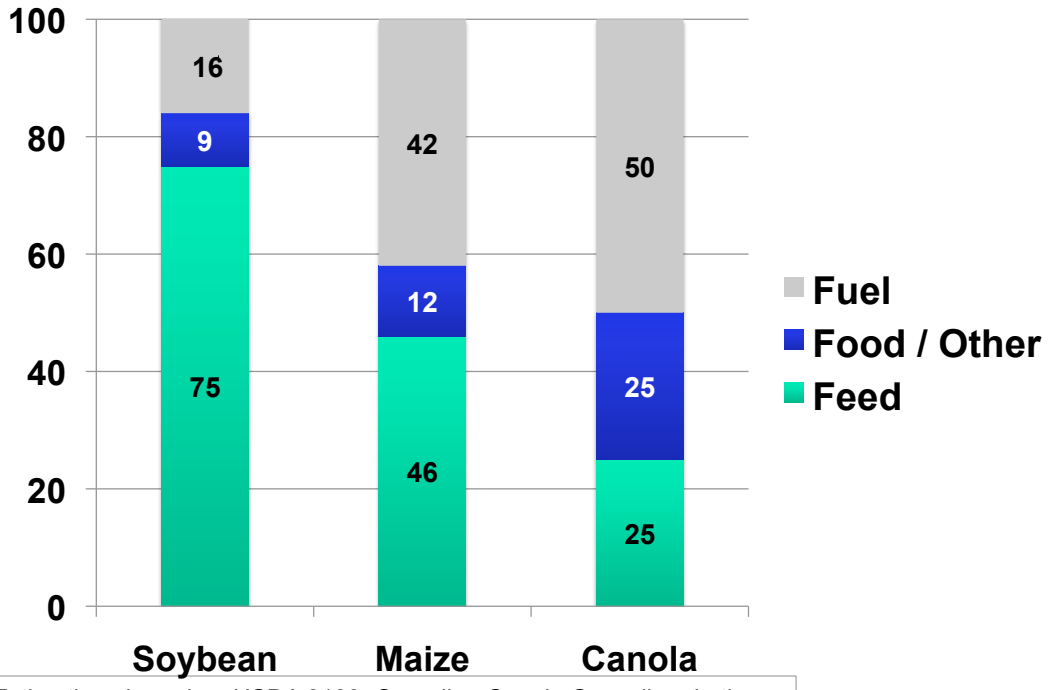
Source: based ISAAA 2002, 2013

GM Characteristics 2002 / 2012



Source: ISAAA 2002, 2013

For What is GM Harvest Used?



Source: Estimations based on USDA 2103, Canadian Canola Council and others

For What is GM Harvest Used?

Where are we after 30 years of GM plants and 17 years commercial GM agriculture?

- 4 crops (soy, maize, canola, cotton)
  - no major food crop
- 2 characteristics (Ht & Bt)
  - no trait related to consumer benefits or food security
- GM agriculture aims at high-input agriculture producing raw material for industrial purposes:
  - 50% into feed
  - 35% into fuel
  - 15% into food and others

Products from GM Plants in Nutrition

- **Soy: whole soy, meal, protein, oil, lecithin**
  - significant part of food grade soy is non-GM
- **Yellow Maize: fructose syrup, oil, starch, sugars**
  - many raw products for chemical industry
- **White Maize: whole kernels**
  - only South Africa grows food grade GM maize 2012: 1,3 mill ha (0,8% of GM area worldwide)
- **Canola & Cotton: oil**

Source: based on ISAAA 2013, Gouse 2012 and various internet sources

GM Crop Pipeline

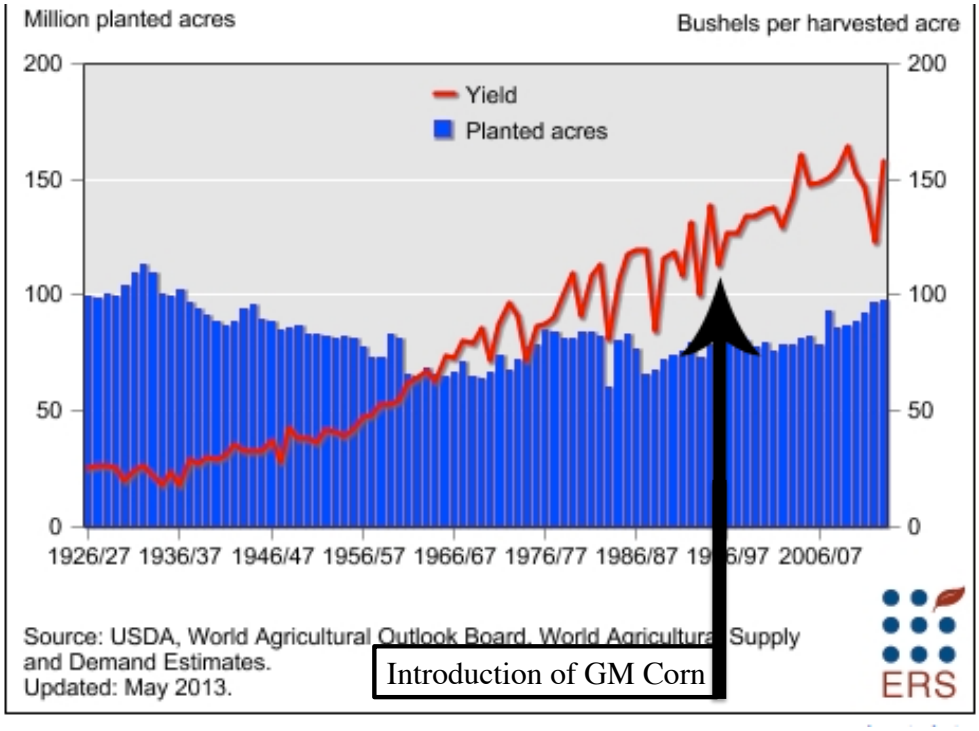
crop	total	IR/Bt (stack)	HT	composition	VR	abiotic stress	FR / NR*	other	failed approval prognosis
total	98	32	23	16	6	6	5	10	35/59
rice	19	8	3	2 (β-carotene)	2	2 (drought, saline)	2		8/14
soybean	16	1 (1)	10	3 (oleic, stearidonic acid)			1*		4/9
cotton	15	12 (1)	2						10/10
maize	15	5	2	6 (lysine, phytase, oleic acids, amino acids)		2 (drought)			5/7
canola	9		4	3 (oil, fatty acids)			1	1 (na)	3/5
potato	8			2 (starch)	2		1	3 (dwarf, sweetening, na)	3/5
others	16	4	2		2	2		6 (shalf life, sterile, na)	2/9

Source: compilation based on Stein & Rodríguez-Cerezo 2009

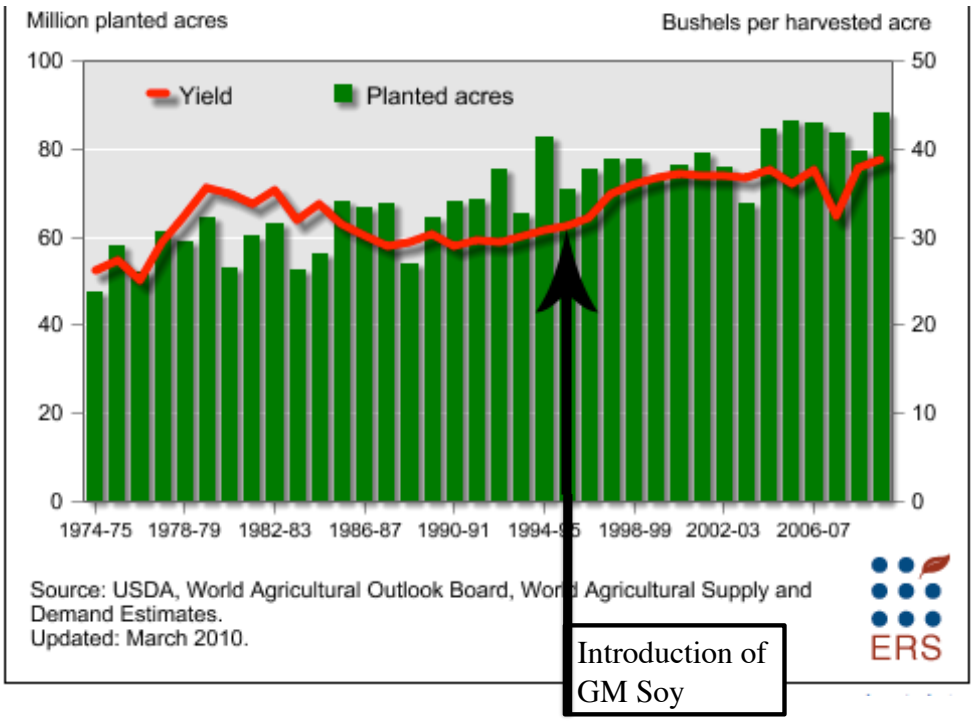
GM Breeding: Simple Paradigm

- GM breeding builds on simple biological paradigm: One-gene-one-product
- Complex physio-ecological characteristics and molecular plant-pathogen interactions are not understood
- Successful theories and models for (single)-gene interventions are lacking
- Sustainable pathogene resistance and yield increase has variety of causes at genetic, cellular and organism level
- Necessary multi-gene interventions are best performed by non-GM methods

U.S. Corn Acreages and Yield



U.S. Soy Acreages and Yield



Interventions more complex than HT and Bt tend to fail

- U.S. field trials approved until 2009:
  - virus resistance: 988
  - fungal resistance: 854
  - no major commercial crops developed until 2013 but 1 GM papaya (526 ha in 2011)
- Fungus-resistant (Black sigatoka) GM banana field trials (Uganda) failed
- Anti-allergenic rice (Japan) and wheat (Germany) failed, allergenicity was caused by more proteins than thought

Source: based on USDA 2013, Meyer 2011, Meyer 1998 and others

Planned GM Crop Approvals With High Food Relevance (1)

- **Arctic® Apple:** U.S. deregulation started in 2010, non-browning Granny Smith and Golden Delicious
- RNAi-based gene-silencing of 4 polyphenol oxidase genes
- New characteristic primarily beneficial for apple processing industry
- Intervention does not address main sustainability deficits in apple production as dependence on pesticide input, loss of biological diversity, uniformity of products

Source: based on Biofortified Blog 2013 and other internet sources

Planned GM Crop Approvals With High Food Relevance (2)

- **Innate® Potato:** U.S. deregulation started in 2013, using genetic material from (wild) potatoes in Russet Burbank, Ranger Russet, and Atlantic
- RNAi-based suppression of polyphenol oxidase reduces black-spot bruising
- Reduced degradation of starch to sugars during storage (retaining yellow colour of tuber)
- Reduced asparagine levels (low-acrylamide fries)
- Test whether these characteristics are seen as consumer benefits

Source: based on Simplot Inc. internet page and other internet sources

Examples for Non-GE Breeding Announced in 2013

Crop	Characteristics	Breeder
Cowpeas	High protein, drought tolerance, insect resistance Striga resistance	Texas A&M University, USA IITA, Nigeria
Rice	Salt tolerance	IRRI, Philippines
Maize	Drought tolerance b-carotene	IITA/DTMA, Nigeria Feed the Future, USA
Napier grass	Fungi resistance	KARI, Kenya
Tomato	Pest & virus resistance	Cornell University, USA
Beans	High yield	IRAD, Cameroon
Cassava	High yield, disease resistance	IITA, Nigeria

Source: based on 2013 postings of the GENET-news information service