The Science, Politics and Trade of Agricultural Biotechnology: Bottlenecks in Europe

Bottlenecks in Europe

Justus Wesseler

Chair Agricultural and Food Economics

Center of Life and Food Sciences Weihenstephan

Technische Universität München

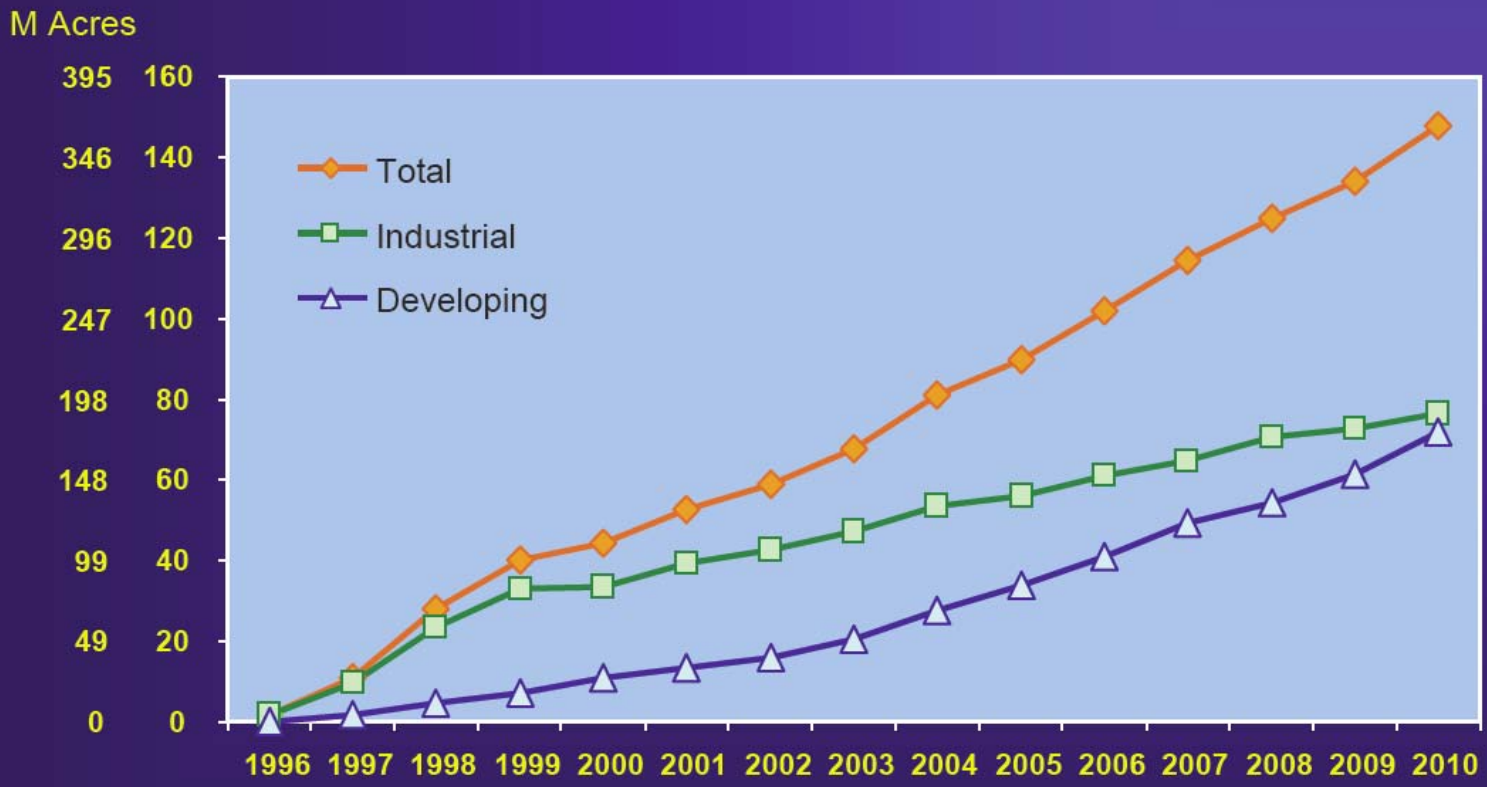
Outline

- overview about planting
- concerns in the EU
- precautionary principle
- co-existence
- international dimension

Why GM crops ?

- **Advantages in plant breeding**
  - more specific
  - faster success
  - larger gene reservoir (elite varieties × any gene source)
- **Potential applications**
  - sustainable food, feed, fibre, and fuel production
  - health (pharmaceuticals)
- **A number of farm-level benefits**
  - direct environmental benefits (e.g. pesticide use, soil erosion, land use)
  - lower levels of mycotoxins (ECB resistant maize)
  - increase in yield per hectare
  - non-pecuniary benefits

Global Area of Biotech Crops, 1996 to 2010: Industrial and Developing Countries (M Has, M Acres)



Source: Clive James, 2010

Global Area of Biotech Crops, 1996 to 2010: By Crop (Million Hectares, Million Acres)

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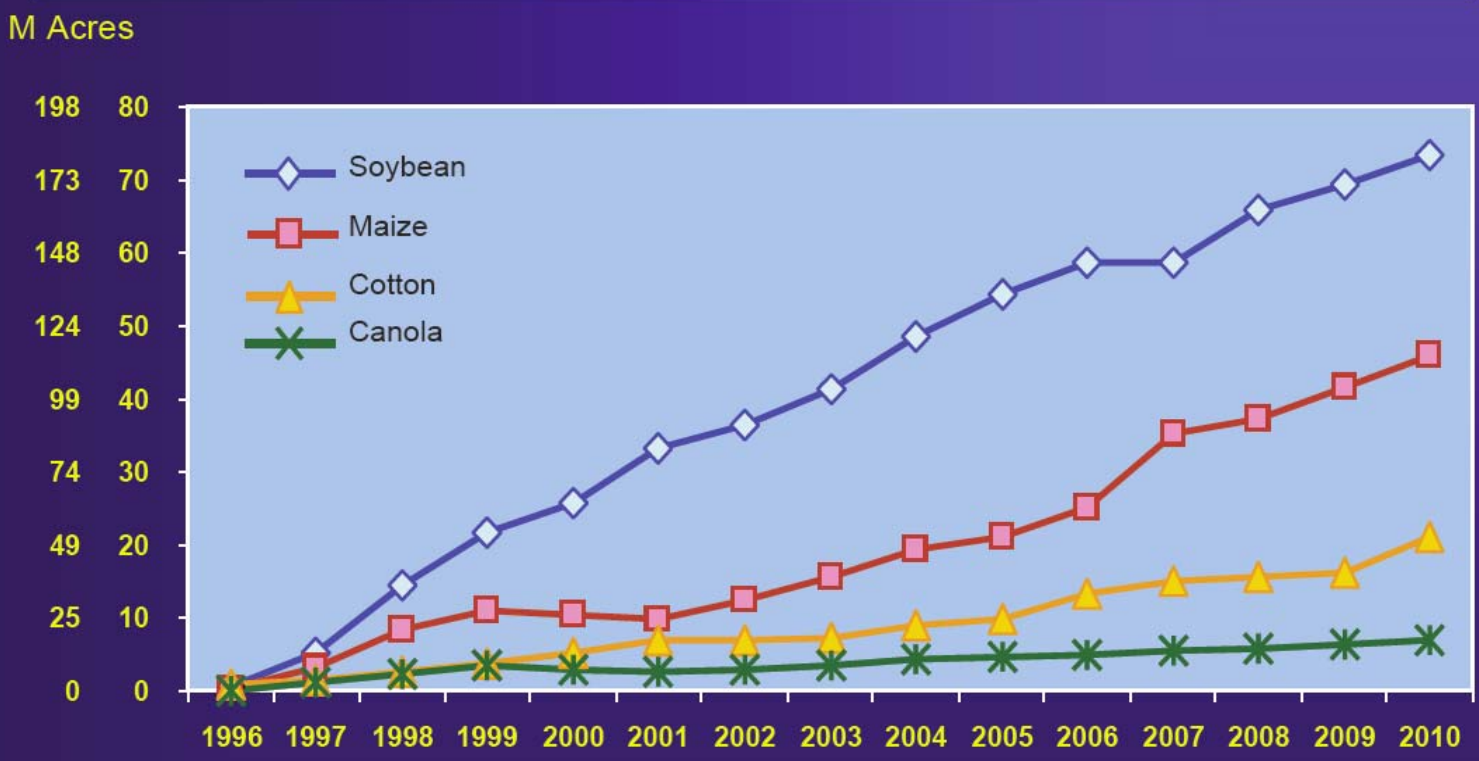
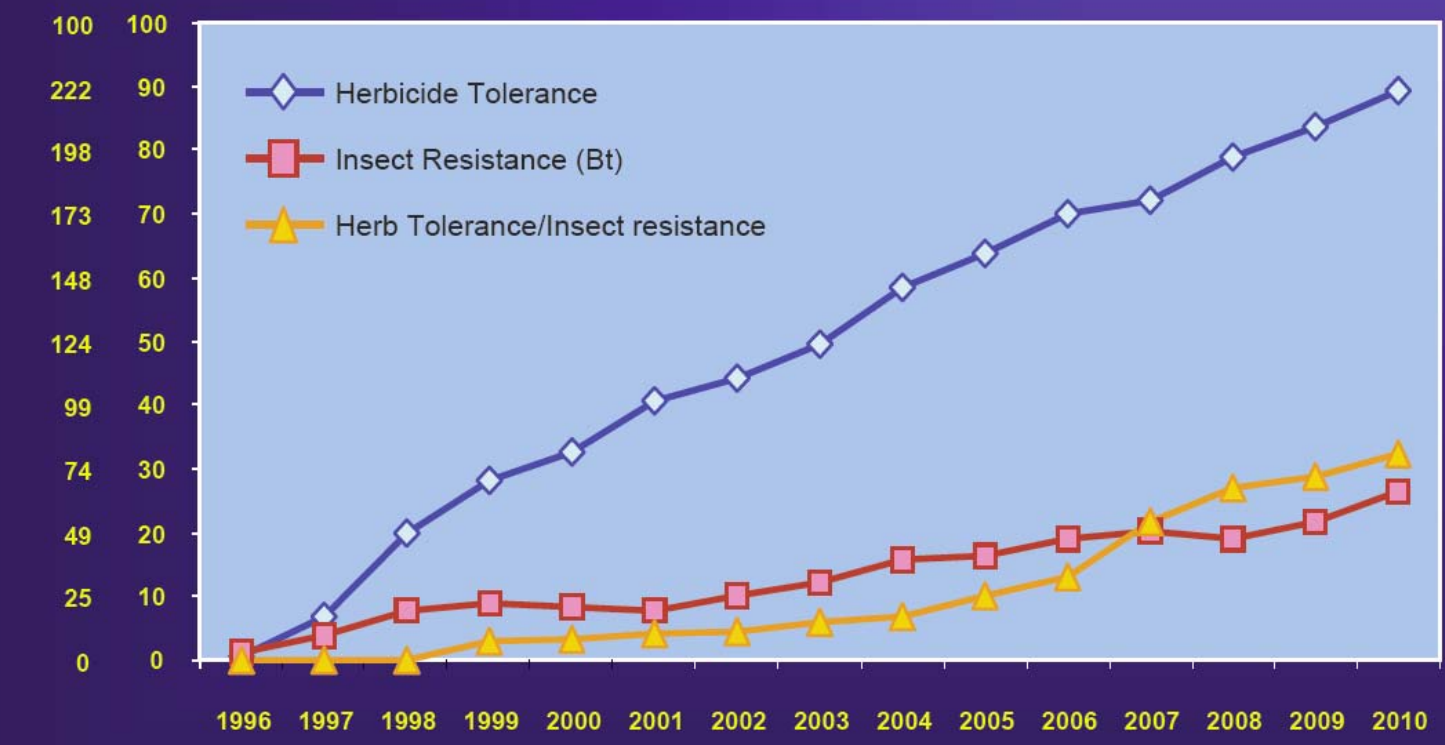


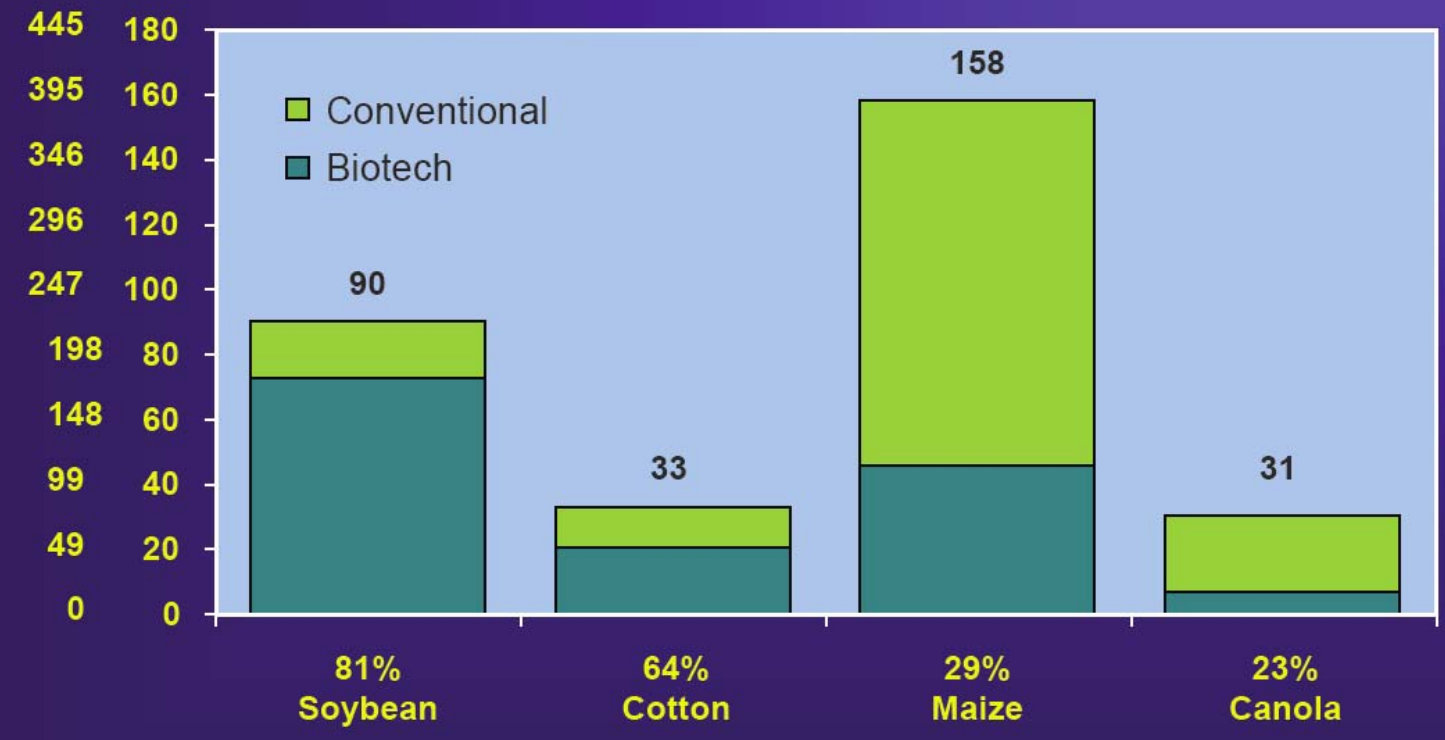
Source: Clive James, 2010

Global Area of Biotech Crops, 1996 to 2010: By Trait (Million Hectares, Million Acres)



Source: Clive James, 2010

Global Adoption Rates (%) for Principal Biotech Crops (Million Hectares, Million Acres), 2010



Source: Clive James, 2010

Projected global welfare gains from GM crops (CGE model results)

Reference	Crop	Year of Study	Annual welfare gain (US$)
Frisvold & Reeves (2007)	Bt cotton	2005	1.4 billion
Elbehri & MacDonlad (2004)	Bt cotton	2001	1.8 billion
Anderson & Yao (2003)	Bt cotton	2005	1.4 billion
Anderson et al. (2008)	Bt cotton	2001	0.7 billion
Nielson & Anderson (2001)	GM oilseeds and maize	-	9.9 billion
Anderson & Yao (2003)	GM oilseeds and maize	-	7.0 billion
Hareau et al. (2005)	Bt rice	-	2.2 billion
Hareau et al. (2005)	Drought-tolerant rice	-	2.5 billion
Hareau et al. (2005)	HT rice	-	2.1 billion
Anderson & Yao (2003)	Bt rice	-	2.0 billion

Source: Qaim, M (2009) The Economics of Genetically Modified Crops. Annual Review of Resources Economics 1:3.1-3.29

Overall Welfare Benefits (Farmers, Consumers, Industry)

- **Farmers**

  => 14 million farmers in 25 countries planted 134 million hectares in 2009

  => in the EU benefits for Bt maize: 194-340 €/ha
  HR maize: 74-234 €/ha

  => two thirds and more of technology benefits at farm level

- **Industry**

  => one third and less of the overall welfare benefits

Overall Welfare Benefits (Farmers, Consumers, Industry)

- **Consumers**

  => direct benefits small (20% and less)

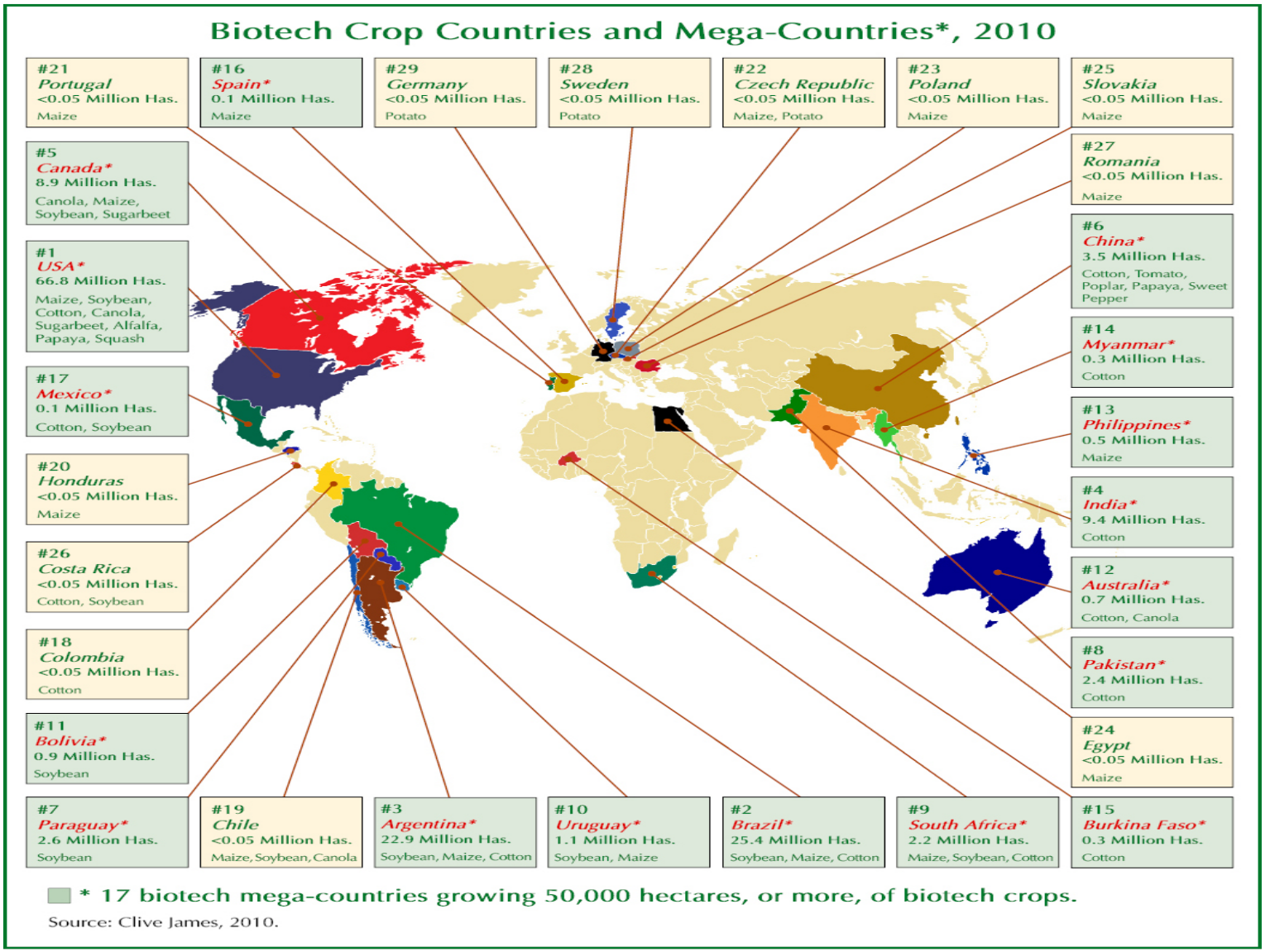
  => farmers are also consumers!

  => indirect environmental benefits
  (substantial for Bt-cotton in China and India, HR crops US and Canada)

Table 1 Average farm-level agronomic and economic effects of Bt crops

Country	Insecticide reduction (%)	Increase in effective yield (%)	Increase in gross margin (US$/ha)	Reference(s)
Bt cotton				
Argentina	47	33	23	Qaim & de Janvry 2003, 2005
Australia	48	0	66	Fitt 2003
China	65	24	470	Pray et al. 2002
India	41	37	135	Qaim et al. 2006, Sadashivappa & Qaim 2009
Mexico	77	9	295	Traxler et al. 2003
South Africa	33	22	91	Thirtle et al. 2003, Gouse et al. 2004
United States	36	10	58	Falck-Zepeda et al. 2000b, Carpenter et al. 2002
Bt maize				
Argentina	0	9	20	Brookes & Barfoot 2005
Philippines	5	34	53	Brookes & Barfoot 2005, Yorobe & Quicoy 2006
South Africa	10	11	42	Brookes & Barfoot 2005, Gouse et al. 2006
Spain	63	6	70	Gómez-Barbero et al. 2008
United States	8	5	12	Naseem & Pray 2004, Fernandez-Cornejo & Li 2005

Source: Qaim, M (2009) The Economics of Genetically Modified Crops. Annual Review of Resources Economics 1:3.1-3.29


Biotech Crop Countries and Mega-Countries*, 2010
#21 Portugal <0.05 Million Has. Maize
#16 Spain* 0.1 Million Has. Maize
#29 Germany <0.05 Million Has. Potato
#28 Sweden <0.05 Million Has. Potato
#22 Czech Republic <0.05 Million Has. Maize, Potato
#23 Poland <0.05 Million Has. Maize
#25 Slovakia <0.05 Million Has. Maize
#5 Canada* 8.9 Million Has. Canola, Maize, Soybean, Sugarbeet
#27 Romania <0.05 Million Has. Maize
#1 USA* 66.8 Million Has. Maize, Soybean, Cotton, Canola, Sugarbeet, Alfalfa, Papaya, Squash
#6 China* 3.5 Million Has. Cotton, Tomato, Poplar, Papaya, Sweet Pepper
#17 Mexico* 0.1 Million Has. Cotton, Soybean
#14 Myanmar* 0.3 Million Has. Cotton
#13 Philippines* 0.5 Million Has. Maize
#20 Honduras <0.05 Million Has. Maize
#4 India* 9.4 Million Has. Cotton
#26 Costa Rica <0.05 Million Has. Cotton, Soybean
#12 Australia* 0.7 Million Has. Cotton, Canola
#18 Colombia <0.05 Million Has. Cotton
#8 Pakistan* 2.4 Million Has. Cotton
#11 Bolivia* 0.9 Million Has. Soybean
#24 Egypt <0.05 Million Has. Maize
#7 Paraguay* 2.6 Million Has. Soybean
#19 Chile <0.05 Million Has. Maize, Soybean, Canola
#3 Argentina* 22.9 Million Has. Soybean, Maize, Cotton
#10 Uruguay* 1.1 Million Has. Soybean, Maize
#2 Brazil* 25.4 Million Has. Soybean, Maize, Cotton
#9 South Africa* 2.2 Million Has. Maize, Soybean, Cotton
#15 Burkina Faso* 0.3 Million Has. Cotton
* 17 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.
Source: Clive James, 2010.

	Cultivation of GM plants in the EU in hectares					
	2005	2006	2007	2008	2009	2010
Spain	53,225	53,667	75,148	79,269	76,057	67726/-
France	492	5,000	21,147	-	-	-, -
Czech Republic	150	1,290	5,000	8,380	6,480	4680/150
Portugal	750	1,250	4,500	4,851	5,094	5500/-
Germany	342	947	2,685	3,171	-	-/15
Slovakia	-	30	900	1.900	875	1740/-
Romania	*110,000	*90,000	350	7,146	3,344	823/-
Poland	-	100	320	3,000	3,000	3500/-
Sweden						-/80
Total GM Crops (Amflora, 2010)	54,959	62,284	110,050	107,717	94,750	83969/245

Source: GMO-Compass, 2010.

*Cultivation of GM soybeans


GMO-free areas in the EU
GMO-free regions
GMO-free province, department or prefecture
Region which signed the Florence Charter and member of the European GMO-Free Regions Network
GMO-free municipality or former declared GMO-free area
Non-EU areas (shaded)
Madeira Islands
Canary Islands
GMO free
EUROPE
2010
www.gmo-free-regions.org

The European Perspective

- The irreversible costs of introducing transgenic crops were of major concern to decision makers in the EU:

- In June 1999 five member states declared they would block new approvals of genetically modified organism (GMOs) until the European Commission proposed additional legislation governing their introduction (Commission of the European Communities, 1999).

=> The decision became to be known as the ***quasi moratorium*** on GMOs.

Declaration by the Danish, Greek, French, Italian, and Luxembourg delegations concerning the suspension of new GMO authorisations

The Governments of the following Member States (**Denmark, Greece, France, Italy and Luxembourg**), in exercising the powers vested in them regarding the growing and placing on the market of genetically modified organisms (GMOs),

given the need to put in place a tighter, more transparent framework, in particular for **risk assessment**, having regard to the specifics of **European ecosystems**, monitoring and **labelling**,

given the need to restore public and market confidence,

point to the importance of the Commission submitting without delay full draft rules ensuring **labelling and traceability** of GMOs and GMO-derived products and state that, pending the adoption of such rules, in accordance with **preventive and precautionary principles**, they will take steps to have any new authorisations for growing and placing on the market suspended.

Declaration by the **Austrian, Belgian, Finnish, German, Netherlands, Spanish and Swedish** delegations

…

Against this background the Governments of these Member States, having regard to the precautionary principle set out in Article 174(2) of the Treaty, intend:

- to take a thoroughly **precautionary approach** in dealing with notifications and authorizations for the placing on the market of GMOs,

- not to authorise the placing on the market of any GMOs until it is demonstrated that there is no adverse effect on the environment and human health, and

- to the extent legally possible to apply immediately the principles, especially regarding **traceability and labelling**, laid down in the political agreement for a revision of Directive 90/220/EEC reached by the Council on 24/25 June 1999.

…

Directive:

- 2001/18/EC: on deliberate release of GMOs (includes the safeguard clause)

Regulations:

- 1829/2003: on genetically modified food and feed

- 1830/2003: on labelling and traceability of GMOs

- 1946/2003: on the transboundary movements of GMOs

Recommendation:

- 2003/556/EC: on coexistence of GM crops

Labelling of GM-Food and GM-Feed – Examples [11]

till 2003

since 2003

GMO-type	EXAMPLE	Labelling Required at present	Labelling required in future
GM plant	Chicory[12]	Yes	Yes
GM seed	Maize seeds	Yes	Yes
GM food	Maize, Soybean sprouts, Tomato	Yes	Yes
Food produced from GMOs	Maize flour [13]	Yes	Yes
	Highly refined maize oil, soybean oil, rape seed oil [14]	No	Yes
	Glucose syrup produced from maize starch [14]	No	Yes
Food from animals fed on GM feed	Eggs, meat, milk	No	No
Food produced with the help of a GM enzyme	bakery products produced with the help of amylase	No	No
Food additive/flavouring produced from GMOs	Highly filtered lecithin extracted from GM soybeans used in chocolate [14]	No	Yes
GM Feed	Maize[15]	Yes	Yes
Feed produced from a GMO	Corn gluten feed, Soybean meal	No	Yes
Feed additive produced from a GMO	Vitamin B2 (riboflavin)	No	Yes

Source: EC (2003) Question and Answers on the regulations of GMOs in the EU. Memo/03/196

Precautionary Principle

This principle was enshrined at the 1992 Rio Conference on the Environment and Development, during which the Rio Declaration was adopted, whose principle 15 states that:

"*in order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*".

- Goes back to the "Vorsorgeprinzip" in German Law.
- Relevance in the 1980's acid rain and forest death in Europe.

Interpretations of the Precautionary Principle

- Strong interpretation: the prospect of harmful effects of a new technology take precedence over the prospect of beneficial effects.

  Harmful effects => catastrophic potential.

  The infinite costs of a possible catastrophic outcome necessarily outweigh even the slightest probability of its occurrence.

Interpretations of the Precautionary Principle

The logic of Pascal's wager (Henk van den Belt, 2003)

"Given an unknown but non-zero probability of God's existence and the infinity of the reward of an eternal life, the rational option would be to conduct one's earthly life as if God indeed exists."

'Many gods' objection:
"Consider the possible existence of another deity than God, say Odin. If Odin is jealous, he will resent our worship of God, and we will have to pay an infinite price for our mistake.

Never mind that Odin's existence may not seem likely or plausible to us. It is sufficient that we cannot exclude the possibility that he exists with absolute certainty.

So the very same logic of Pascal's wager would lead us to adopt the opposite conclusion not to worship God. Pascal's argument, then, cannot be valid."

Van den Belt, Henk (2003) Debating the Precautionary Principle: "Guilty until Proven Innocent" or "Innocent until Proven Guilty"? *Plant Physiology*, 132, 1122–1126

Interpretations of the Precautionary Principle

In the words of Arrow et al. 1996:

"… regulate until the incremental benefits from regulation are just off-set by the incremental costs. In practice, however, the problem is much more difficult, in large part because of inherent problems in measuring marginal benefits and costs."

In addition, other issues become relevant as well: distribution, compensation, discount rate and all other problems of economic benefit-cost analysis.

K. J. Arrow, M. L. Cropper, G. C. Eads, R. W. Hahn, L. B. Lave, R. G. Noll, P. R. Portney, M. Russell, R. Schmalensee, V. K. Smith, R. N. Stavins (1996): Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation? Science 272, 12 April, 221-222.

Interpretations of the Precautionary Principle

Economic assessment under the precautionary principle:

- Irreversible costs of the technology
- Opportunity costs: irreversible benefits of the technology and foregone reversible net-benefits of delayed introduction

Economic assessment under the precautionary principle

- irreversible and reversible benefits and costs
- uncertainty

=> real option approach (Arrow and Fisher, 1974; Henry, 1974; Black and Scholes, 1973; Merton, 1973;)

- $I > I^* = \gamma W + R$ (γ, factor considering uncertainty and irreversibility;
  W, net-reversible benefits;
  R, irreversible benefits)
- I^*: Maximum Incremental Social Tolerable Irreversible Costs **(MISTICs)**

SIRBs, SIIBs, Hurdle Rates, and MISTICs for Bt grain maize on average per year for the EU-15 at 10.5% discount rate w/ and w/o CAP subsidies (in 2005 prices).

Country	SIRB		SIIB		Hurdle Rate	MISTIC			
	Mio. €	€/ha	Mio. €	€/ha		Mio. €	€/ha	€/capita	€/farmhl.
France	62	204	0.24	0.81	1.14	54	179	0.90	467
Greece	12	280	0.04	1.03	1.79	7	157	0.60	74
Italy	60	299	0.19	0.98	1.23	49	244	0.84	214
Portugal	4	194	0.02	1.08	1.21	4	162	0.36	31
Spain	27	340	0.07	0.90	1.28	21	269	0.51	258
France	36	118	0.24	0.81	1.16	31	102	0.52	267
Greece	7	169	0.04	1.03	2.50	3	69	0.26	32
Italy	37	187	0.19	0.98	1.31	29	143	0.49	125
Portugal	2	87	0.02	1.08	1.19	2	74	0.16	14
Spain	18	223	0.07	0.90	1.03	17	218	0.41	210

Source: Wesseler, Scatasta, Nillesen (2007) The Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) and other Benefits and Costs of Introducing Transgenic Maize in the EU-15. Pedobiologia 51(3):261-269.

Coexistence addresses additional social concerns:

- Co-existence is about giving farmers the practical choice between conventional, organic and GM crop production in compliance with the legal obligations for labelling and purity standards.
- According to Directive 2001/18/EC (Article 26a), Member States may take appropriate measures to avoid the unintended presence of GMOs in other products.
- In order to help the Member States in developing national approaches to coexistence, the Commission adopted, on 23 July 2003, a recommendation (2003/556/EC) on guidelines for the development of national strategies and best practices to ensure the co-existence of genetically modified crops with conventional and organic farming.

Coexistence Policies

Combination:

ex-ante regulation

ex-post liability rules

Defining the Term Coexistence (Benefit)

"A state described by a set of policies exogenous to the farmers that results in the planting of 'organic and/or non-organic-non-GM' and 'GM crops' at the same point in time in a pre-defined region with at least one farm where

$$vc_{G_i}^{n} > vc_{N_i}^{n} \quad and\ one\ where \quad vc_{G_i}^{n} < vc_{N_i}^{n}$$

under a GM farmer property right system and at least one farm where

$$vc_{G_i}^{\ell} > vc_{N_i}^{\ell} \quad and\ one\ where \quad vc_{G_i}^{\ell} < vc_{N_i}^{\ell}$$

under a non-GM farmer property right system."

Important to Consider!

No Coexistence without Threshold Levels!

Ex-ante Regulations

Policy	Countries
Prohibition and approval procedures	
prohibition of planting GM crops in specific areas	AT, DE, HU, LU, PT, SK
case by case approval for each field by local auth.	AT*, HU, IE, SK
compulsory training of farmers planting GM crops to be paid for by the GM farmer	DK, HU, SK
consent from landowner needed	AT, BE, HU, LU, SK
consent from neighbors needed	AT, BE, HU, LU, SK

AT*: parts of Austria only

Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.

Ex-ante Regulations

Policy	Countries
Registration and information duties	
registration of areas in publicly available database	AT*, DE, DK, EE, LT, LV, SK
registration of areas in publicly available database, restricted access	AT*, ES, FI, FR, HU, NL, PL, PT
informing neighboring farmers and landowner	AT, DK, HU, NL, PL, SK
record keeping	CZ, DE, DK, ES, HU, IT, NL, PL, PT

AT*: parts of Austria only

Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.

Ex-ante Regulations

Policy	Countries
Technical segregation measure	
minimum distance requirements	AT, CZ, DE, DK, ES, FR, HU, NL, PL, SK
bufferzones	AT, CZ, ES, FR, PL, SK
rotation intervals	EE, LT, SE

AT*: parts of Austria only

Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.

Distance Requirements for GM Crops in the EU

Country	Maize	OSR	Sugar Beet
Bulgaria	(7000)	(7000)	(7000)
Czech Republic	70 (200)		
Germany	150 (300)		
Denmark	150		20(20)
Hungary	400		
Ireland	50(75)		
Lithuania	200	4000	50
Luxemburg	600		100
Latvia	200	4000	200
Netherlands	25 (250)		1.5 (3.0)
Portugal	200 (300)		
Romania	200		
Slovakia	200 (300)		
Sweden	50		

Numbers in brackets indicate distances to organic fields.

Ex-ante Regulations

Policy	Countries
Insurance measures	
compensation fund paid by GM farmers (levy on GM crops) plus support from the central government	DK
compensation fund paid by private stakeholders	IE, FR, NL, PT, UK
private insurance against damage	AT*, LU

AT*: parts of Austria only

Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.

Ex-Post Liability

Policy	Countries
Legal liability for damages	
liability based on civil law	CZ, ES, HU, SK
fault based liability	AT*, DK, FR, NL
strict liability for GM-farmers	AT*, DE, IE, PL, UK
joint and several liability	DE

AT*: parts of Austria only

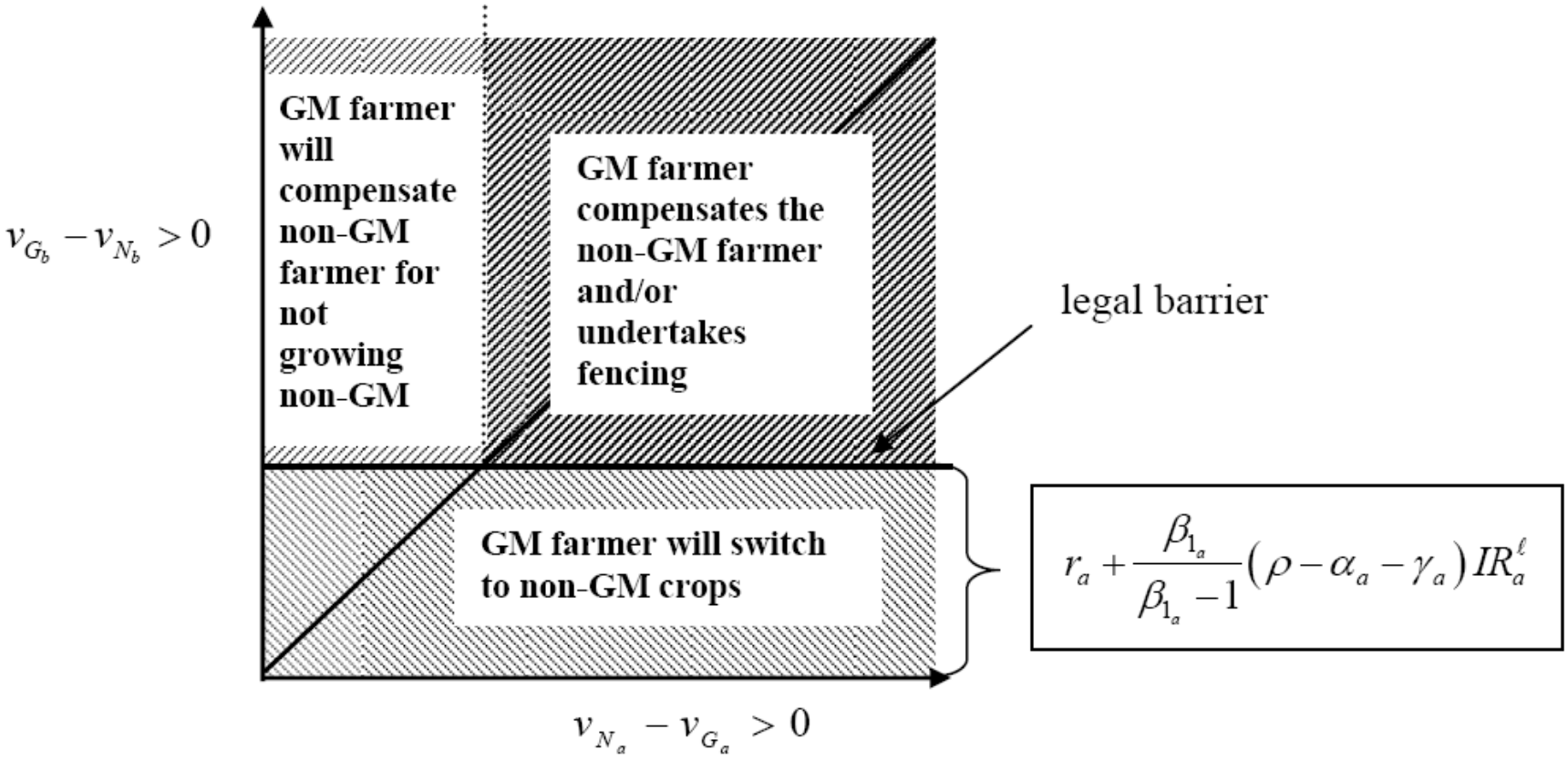
Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.

Ex-Post Liability

Policy	Countries
Proving damage	
burden of proof lies with GM-farmer	AT, DE, FR, IT
burden of proof lies with non-GM farmer	IE, UK
Penalties	
fines for non-compliance with ex-ante regulations	AT, CZ, ES, FR, IT, LV, LT, LU, PL, PT, SK

AT*: parts of Austria only

Source: Beckmann, Volker, Claudio Soregaroli, Justus Wesseler (2006) Co-Existence Rules and Regulations in the European Union. *American Journal of Agricultural Economics* 88(5):1193-1199.



Agglomeration effects induced by ex-ante regulation and ex-post liability

Table 2
Maize gross income, variable production costs, and coexistence values (CV) of the Cadoma cooperative Bt farmer.

	1st producer		2nd producer		3rd producer		4th producer		5th producer	
Maize variety	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Production (t/ha)	11.6	10.5	9.5	8.3	10.5	9.0	10.0	9.0	5.0	4.0
Trading price (€/t)	210	210	210	210	210	210	210	210	210	210
Gross income/ha	2436	2205	1995	1743	2205	1890	2100	1890	1050	840
Variable costs (€/ha)										
Land preparation (no till)	175	175	175	175	175	175	175	175	175	175
Seeds	240	210	240	210	240	210	240	210	240	210
Fertilizer	500	500	500	500	500	500	500	500	300	300
Herbicides	80	80	30	30	91	91	80	80	30	30
Insecticides	–	40	–	20	–	80	–	40	–	20
Water (Pivot)	125	125	125	125	125	125	125	125	125	125
Electricity	100	100	100	100	100	100	100	100	100	100
Harvest	125	125	125	125	125	125	125	125	125	125
Drying	12	12	12	12	11	11	13	13	12	12
Transportation	35	35	35	35	35	35	35	35	35	35
Total costs (€/ha)	1392	1402	1342	1332	1402	1452	1393	1403	1142	1132
Gross margin (€/ha)	1044	803	653	411	803	438	707	487	−92	−292
Ex-ante costs (€/ha)	(30)[a]		(30)		(30)		(30)		(30)	
Ex-post liability	0		0		0		0		0	
Coexistence Value (€/ha)	241		242		365		220		200	
Hectares (ha), Current situation—2007	20	23	23	30	75	80	35	20	35	25
Hectares (ha), hypothetical scenario 80% Bt maize	34.4	8.6	42.4	10.6	124	31	44	11	48	12
Gross margin (€), current situation—2007	20,880	18,469	15,019	12,330	60,225	35,040	24,745	9740	−3220	−7300
Gross margin (€), hypothetical scenario, 0% Bt maize	0	34,529	0	21,783	0	67,890	0	26,785	0	−17,520
Gross margin (€), hypothetical scenario, 80% Bt maize	35,914	6906	27,687	4357	99,572	13,578	31,108	5357	−4416	−3504
Total gross margin, current situation—2007	39,349		27,349		95,265		34,485		−10,520	
	(600)[a]		(690)		(2250)		(1050)		(1050)	
Total gross margin, hypothetical scenario, 100% non-Bt maize	34,529		21,783		67,890		26,785		−17,520	
Total gross margin, hypothetical scenario, 80% Bt maize	42,819 (24.00)[b]		32,044 (47.11)		113,150 (66.67)		36,465 (36.14)		−7920 (221.21)	
	(1032)[a]		(1272)		(3720)		(1320)		(1440)	
CV in €, current situation—2007	4820		5566		27,375		7700		7000	
CV in €, hypothetical scenario, 80% Bt maize	8290		10,261		45,260		9680		9600	

Source: authors' calculations based on data collected from interviews in Portugal, 2007.

[a] Number in brackets indicate the amount paid to the compensation fund as part of the seed price.

[b] Number in brackets indicates the additional gross margin growing Bt maize in per cent in compariosn to the situation in 2007.

International Dimensions

- Approvals in Brazil, China, India, South Africa, United States

  $\Rightarrow$ international trade issues (asynchronous approval, low level presence, research events)

- EU policy impact on Africa:
  - rejection of food aid
  - reduced research in plant breeding
  - Cartagena Protocol: socio-economic assessment

Case study on GM banana in Uganda

=> GM banana resistant to biotic stresses

=> higher yield and quality of banana

=> survey among rural und urban banana consumers in Uganda in 2007

Source: Kikulwe (2010) On the introduction of genetically modified bananas in Uganda: social benefits, costs, and consumer preferences. PhD-thesis, Wageningen University

Characteristics of consumers belonging to the two segments.

Consumer characteristics	Segment 1:*potential GM banana consumers* (N=245)	Segment 2:*potential GM banana opponents* (N=176)
	Mean	
Age***	36.82	46.28
Household size**	6.42	5.67
Banana acreage (ha)	0.46	0.44
Household monthly income in UGX[a]***	143280	266396
	Percent	
Location, urban =1***	15.51	57.95
Gender, female=1	40.00	47.72
Off-farm employment, Yes =1***	46.94	61.93
College or university education***	5.71	15.34
Grow banana***	93.06	62.50
Self-sufficient, No =1***	66.94	47.72

Note: numbers in the parentheses are standard deviations**.** * indicates significance between means and or distributions of segment 1 and segment 2 members at the 10 percent level, ** significance at the 5 percent level and *** significance at the 1 percent level.

Segment specific valuation of banana bunch attributes: percentage change in price.

Banana attribute	Segment 1 *potential GM banana consumers* (N=285)	Segment 2 *potential GM banana opponents* (N=176)	Weighted average (N=421)
Medium bunch size**	31.1	37.7	33.8
Large bunch size***	43.1	56.1	48.6
Medium benefit***	11.2	-20.9	-2.3
Large benefit***	18.1	-75.3	-21.1
GM biotechnology***	42.5	-62.4	-1.5

Notes: numbers in parentheses are the 95 percent confidence intervals. Consumers' valuation of banana attributes were calculated with the Delta method of the Wald procedure contained within the LIMDEP 8.0 NLOGIT 3.0. Numbers represent the percentage change in total price per banana bunch. *denotes significance at the 10 percent level, ** significance at the 5 percent level and *** significance at the 1 percent level.

Concluding

1. EU has addressed concerns of the ‘quasi’ moratorium
2. Approvals still limited => political economy problem
3. Coexistence policy supports regional agglomeration, but not necessarily a constraint for adoption
4. EU policy important implications for Africa

Challenges

1. AAP, LLP, IP: implications for supply chains (feed – food)

   => governance issues (EFSA capacity), sustainability issues

2. Approvals still limited => political economy problem

   => Barroso proposal a possible solution?

3. Coexistence policy supports regional agglomeration

   => possible exit?

   => regional supply chain effects?

Challenges

4. Restrictive Ex-ante Regulations Reduces Competitiveness / Food Security

   => Western Corn Rootworm control, wheat stem rust (Ug99)

   => efficient regulatory responses?

5. International implications of EU policies

   => implementing Cartagena protocol (socio-economic assessment)

   => trade with developing countries

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References (not cited in the slides):

Ansink, Erik and Justus Wesseler (2009): Quantifying type I and type II errors in decision-making under uncertainty: The case of GM crops. *Letters in Spatial and Resource Sciences* 2(1):61-66.

Beckmann, Volker, Claudio Soregaroli, Justus Wesseler: Coexistence: Coexistence of genetically modified (GM) and non-modified (non GM) crops: Are the two main property rights regimes equivalent with respect to the coexistence value? In "Genetically modified food and global welfare" edited by Colin Carter, GianCarlo Moschini and Ian Sheldon. Volume in Frontiers of Economics and Globalization Series. Bingley, UK: Emerald Group Publishing. Forthcoming.

Beckmann, Volker, Claudio Soregaroli, and Justus Wesseler (2010). Ex-Ante Regulation and Ex-Post Liability under Uncertainty and Irreversibility: Governing the Coexistence of GM Crops. *Economics: The Open-Access, Open-Assessment E-Journal*, Vol. 4, 2010-9.

Scatasta, Sara, Justus Wesseler, Jill Hobbs (2007): Differentiating the consumer benefits from labelling of GM food products. *Agriculture Economics* 37(2-3):237-242.

Skevas, Theodoros, Pedro Fevereiro, Justus Wesseler: Coexistence Regulations & Agriculture Production: A Case Study of Five Bt Maize Producers in Portugal. *Ecological Economics.* doi:10.1016/j.ecolecon.2010.07.007.

Wesseler, Justus (ed.) (2005): Environmental Costs and Benefits of Transgenic Crops. Dordrecht, NL: Springer Press.

References (not cited in the slides):

Wesseler, Justus and El Hadji Fall (2010): Potential damage costs of Diabrotica virgifera virgifera infestation in Europe – the “no control” scenario. *Journal of Applied Entomology* 134(5): 385-394.

Wesseler, Justus, Sara Scatasta, Eleonora Nillesen (2007): The Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) and other Benefits and Costs of Introducing Transgenic Maize in the EU-15. *Pedobiologia* 51(3):261-269.

Wesseler, Justus, Sara Scatasta, El Hadji Fall: Environmental Benefits and Costs of GM Crops. In "Genetically modified food and global welfare" edited by Colin Carter, GianCarlo Moschini and Ian Sheldon. Volume in Frontiers of Economics and Globalization Series. Bingley, UK: Emerald Group Publishing. Forthcoming.

EU Directives/Regulations/Recommendations/ Communications:

Council of the European Union (2006). Press Release 2730th Council Meeting Agriculture and Fisheries. 9406/99 (Presse 132). Brussels.

Council of the European Union (1999). Press Release 2194th Council Meeting Environment. 9170/06 (Presse 203). Brussels. (Quasi Moratorium)

CEC (2009). Report from the Commission to the Council and the European Parliament: on the coexistence of genetically modified crops with conventional and organic farming. COM(2009) 153, Brussels.

CEC (2007). Economic impact of unapproved GMOs on EU feed imports and livestock production. Directorate-General for Agriculture and Rural Development. Brussels. Available at: http://ec.europa.eu/agriculture/envir/gmo/economic_impactGMOs_en.pdf.

CEC (2003). Commission Recommendation of 23 July 2003 on Guidelines for the Development of National Strategies and Best Practices to Ensure the Coexistence of Genetically Modified Crops with Conventional and Organic Farming. Official Journal of the European Communities L189/36-47, July 29, 2003.

EU Directives/Regulations/Recommendations/ Communications:

CEC (2003). Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed. Official Journal of the European Union, L 268/1-23.

CEC (2003). Regulation (EC) No 1830/2003 of the European Parliament and of the Council of 22 September 2003 concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC. Official Journal of the European Union, L 268/24-28.

CEC (2003) Regulation (EC) No 1946/2003 of the European Parliament and of the Council of 15 July 2003 on transboundary movements of genetically modified organisms. Official Journal of the European Union, L 287/1-10.

CEC (2001). Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2002 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC. Official Journal of the European Communities L106/1-38, April 17, 2001.

Web-sites:

http://www.gmo-compass.org/eng/home/

EU Transcontainer project: http://www.youtube.com/results?search_query=transcontainer&aq=f.

EFSA: http://www.efsa.europa.eu/de/

BVL: http://www.bvl.bund.de/cln_007/nn_491806/DE/06__Gentechnik/gentechnik__node.html__nnn=true