Biotechnologies and Agrifood Strategies:

Opportunities, Threats and Economic Implications

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Outline

- Introduction
- Opportunities and Threats
- Implications (focus on retailers)
- Conclusion

Introduction: history

Year	Event
1973	Development of rDNA technology
1980	Bayh-Dole act, providing intellectual property right to organisation and individuals from inventions with public funding in the US.
1982	Vaccine against swine diarrhoea (The Netherlands) and production of human insulin (US) by means of rDNA technology
1986	OECD publication on “Recombinant DNA safety considerations”, so called “Blue Book”, setting international standards for safety assessments.
1990	Hermann the bull, the first genetically engineered bovine, was born. Female off-springs of Hermann the Bull would produce milk with a high content of lactoferrin to be used to strengthen the immune system of humans. Product developed by Pharming Group N.V., The Netherlands

Introduction: history

Year	Event
1995	Flavr Savr tomato introduced by Calgene (US) but withdrawn in 1999.
1996	Dolly, a cloned sheep was born.
1998	First GE crop approved for cultivation in the EU (MON810)
1999	Apad Pusztai claims negative effects of GM technology on the biology of rats.
1999	Study on mortality effects of pollen from genetically engineered plants on larvae of Monarch Butterflies published in Nature.
1999	Environmental Council of the EC calls for a temporary ban of approvals of GMOs (“quasi moratorium”)
2000	StarLink Case: traces of StarLink corn, not approved for human consumption were found in food products (taco shells).

Introduction: history

Year	Event
2001	EU Directive 2001/18 on the deliberate release of GMOs into the environment published. Includes the safeguard clause.
2002	European Food Safety Authority established. Tasks among others the environmental and food safety assessment of genetically modified organisms (GMOs).
2002	ProdiGene case in the US. Field trials not correctly managed. Draw back for pharmaceutical crops. Stronger regulations.
2003	Regulation 1830/2003 on traceability and labelling of GMOs published. Introduces the 0.9% threshold level for labelling.
2009	Study on the negative effect of Bt maize and the two-spot ladybird published used as an argument by the German government to ban the cultivation of MON810.
2009	Lisbon Treaty enters into force on December 1, 2009. Among others some changes in the approval process of GMOs including explicit deadlines for different steps.

Introduction: history

Year	Event
2011	Judgement on the content of GM pollen in honey by the European Court of Justice.
2011	Enzyme regulation: COMMISSION REGULATION (EU) No 234/2011 of 10 March 2011 implementing Regulation (EC) No 1331/2008 of the European Parliament and of the Council establishing a common authorisation procedure for food additives, food enzymes and food flavourings
2012	Study published by Seralini et al. claiming toxic health effects of herbicide resistant maize as well as glyphosate. The study was retracted by the publishing journal in 2013.
2013	TTIP negotiations launched. Approval of GMOs, hormone beef and investor protection rights important issues.
2014	Opt-out proposal under the Greek presidency

Opportunities and Threads

- Health and environmental effects
  - health benefits: e.g. Vitamin A, fumonisin reduction
  - reduction in AI emissions
  - reduction GHG emissions
  - reduction in land use pressure
  - increase in glyphosate resistance
  - build-up of pest resistance

Fumonisin content in corn from field trials

		Fumonisin (mg/kg)	
Place	***Anno***	**Mais Bt**	**Conv.**
Italy	*1997*	**2,0**	**19,8**
	1998	**5,4**	**31,6**
	1999	**1,4**	**3,9**
	1997	**2,0**	**20,0**
	2005	**0,05**	**6,0**
France	*2005*	**0,3**	**6,1**
	2006	**0,4**	**5,6**
Turkey	*2001*	**2,5**	**16,5**
	2002	**0,7**	**14,7**

Source: Courtesy of Morandini (2014)

Magnitude of Vitamin A deficiency

- 125 million children suffer from Vitamin A deficiency reduction
- 250,000 to 500,000 children go blind every year
- more than half die within a year of becoming blind
- results in stunted growth
- increased vulnerability to common childhood diseases
- 1,425,000 life-year's lost over past decade in India (Wesseler and Zilberman, 2014)

Environmental effects

Table 7: GM crop environmental benefits from lower insecticide and herbicide use 1996-2012: developing versus developed countries

	Change in field EIQ impact (in terms of million field EIQ/ha units): developed countries	Change in field EIQ impact (in terms of million field EIQ/ha units): developing countries
GM HT soybeans	-4,773.9	-1,880.2
GM HT maize	-5,585.9	-438.8
GM HT cotton	-351.0	-109.3
GM HT canola	-509.1	0
GM IR maize	-1,574.4	-640.8

Table 84: Summary of carbon sequestration impact 1996-2012

Crop/trait/country	Permanent fuel saving (million litres)	Potential carbon dioxide saving from fuel saving (million kg)	Potential carbon dioxide saving from soil carbon sequestration (million kg)
US: GM HT soybeans	943	2,519	12,825
Argentina: GM HT soybeans	2,375	6,341	96,418

Source: Brookes and Barfoot (2014) GM crops: global socio-economic and environmental impacts 1996-2012.

Yield effects

Study	GE Crop			
	Soybean	Cotton	Maize	Oilseed Rape
Sexton and Zilberman, 2011	13	65	45	25
Finger et al., 2011[a]		1 – 51	6 – 25	
Barrows et al., 2014b	1 - 24	17 - 152	3 - 25	

Note: a) only insect resistant traits have been considered.
The studies include all countries cultivating the GE crops mentioned.

Opportunities and Threads

- Market and product differentiation
  - Labelling policies
  - Asynchronous approval processes
  - Threshold levels: research events, unapproved events, low level presence,
  - (Niche) markets for GM-free labelled products

Labelling policies

Table 2. Characteristics of national labeling systems in major countries as of February 2007 divided into three groups according to the degree of stringency of their regulation.

Major Country	Labeling type[a]	Product/ process	Coverage	Major exemptions	Threshold level
European Union	Mandatory, & national voluntary guidelines	Process	Food, feed, additives, flavorings, products derived from GM, restaurants	Meat and animal products	0.9%
Brazil[b]	Mandatory	Process	Food, feed, products derived from GM, meat and animal products	Virtually none	1%
China	Mandatory	Process	List; products derived from GM, restaurants	Outside of list	None (0%)
Australia-New Zealand	Mandatory & voluntary	Product	All products based on content	Processed products	1%
Japan	Mandatory & voluntary	Product	List of food items	Processed products	5%[f]
Indonesia[b]	Mandatory	Product	List of food items	Outside of list	5%[f]
Russia	Mandatory	Product	All products based on content	Feed	0.9%
Saudi Arabia	Mandatory	Product	List of food items	Outside of list, restaurants	1%
South Korea	Mandatory & voluntary	Product	List of food items	Processed products	3%[g]
Taiwan	Mandatory & voluntary	Product	List of food items	Outside of list	5%
Thailand[c]	Mandatory	Product	List of food items	Outside of list	5%[f]
Argentina[d]	Voluntary	Product	-----Not specified- all products based on content-----		
South Africa	Voluntary	Product	-----Not specified- all products based on content-----		
Philippines[e]	Voluntary	Product	All products based on content		5%
Canada	Voluntary	Product	All products based on content		5%
United States	Voluntary	Product	All products based on content		n/a

[a] *For substantial equivalent products only.*
[b] *To our knowledge, the labeling regulation has not been fully implemented.*
[c] *Implemented with "voluntary" enforcement. Penalties are applied in case of reported fraud.*
[d] *No specific law.*
[e] *Proposed labeling regulation.*
[f] *On three main ingredients in each product.*
[g] *On top five major ingredients in each product.*
Source: Carter and Gruère (2003a), Cevallos (2006), Cloutier (2006), Foster & French (2007), Haigh (2004), USDA (2006), Wongruang (2006).

Labeling Requirements for GMOs in the EU

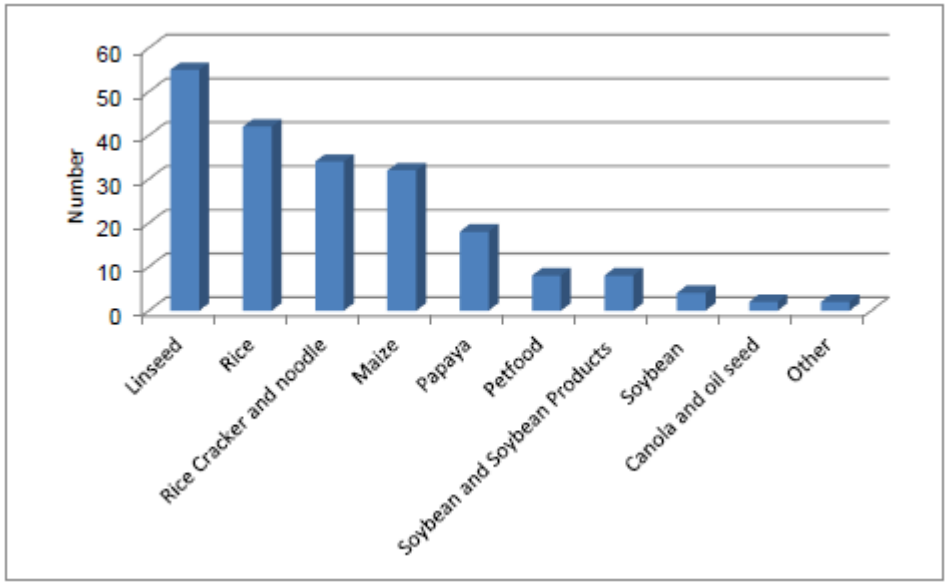
GM product	Example	Labeling requirement
GM plants, seeds, and food	Maize, maize seed, cotton seed, soybean sprouts, tomato	Yes
Food produced from GMOs	Maize flour, soybean oil, rape seed oil	Yes
Food additive/flavouring produced from GMOs	Highly filtered lecithin extracted from GM soybeans	Yes
GM feed	Maize	Yes
Feed produced from a GMO	corn gluten feed, soybean meal	Yes
Feed additive produced from a GMO	Vitamin B2	Yes
Food from animals fed on GM feed	Eggs, meat, milk	No
Food produced with the help of a GM enzyme	Bakery products produced with the help of amylase	No

Low level and adventitious presence

Reported cases of LLP/AP

Total	198
2002 – 2009 (8 years)	60
2009 – 2013 (latest 5 years	138

Reported cases of LLP/AP by commodity



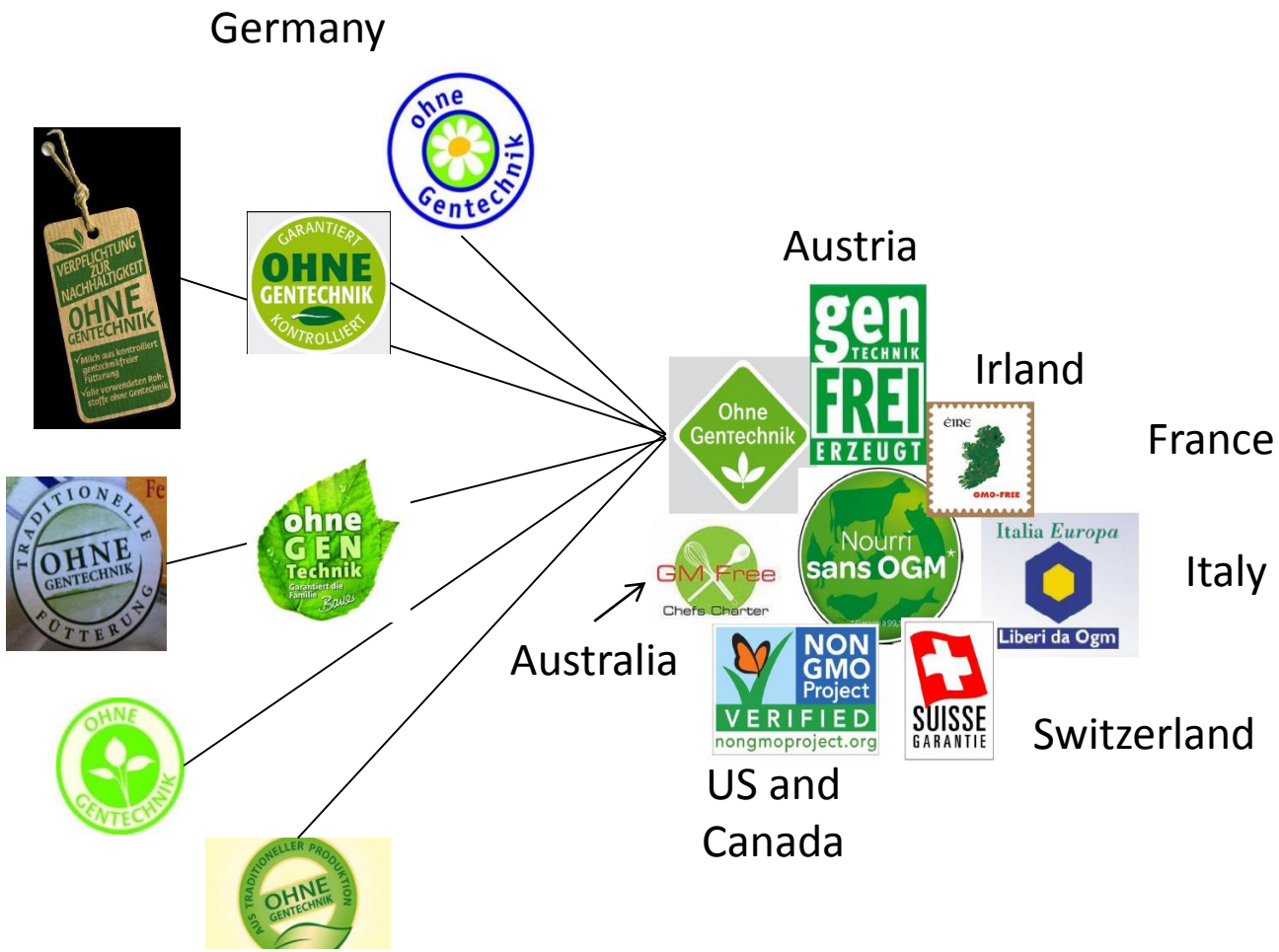
Source: FAO, 2014

“GM-free” labels

Country	Policy
Austria	Guideline under the Austrian Codex Alimentarius Commission, Decree by the Ministry of Health, Part of the Austrian „Food Book“
France	Legally binding Ordinance on Food without GMOs
Germany	Legally binding regulation (VLOG)
Slovenia	Amendment of the Provincial Law of South Tyrol
South Tyrol	Standard by the Institute for Control and Certification University Maribor (Standard Register since summer 2011)

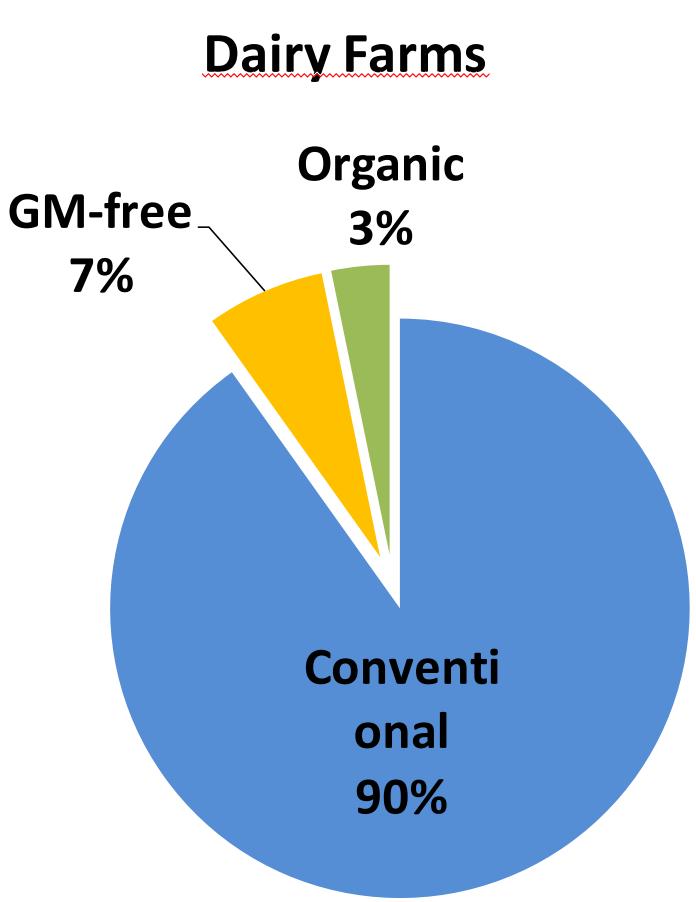
Source: Gaugitsch, 2013

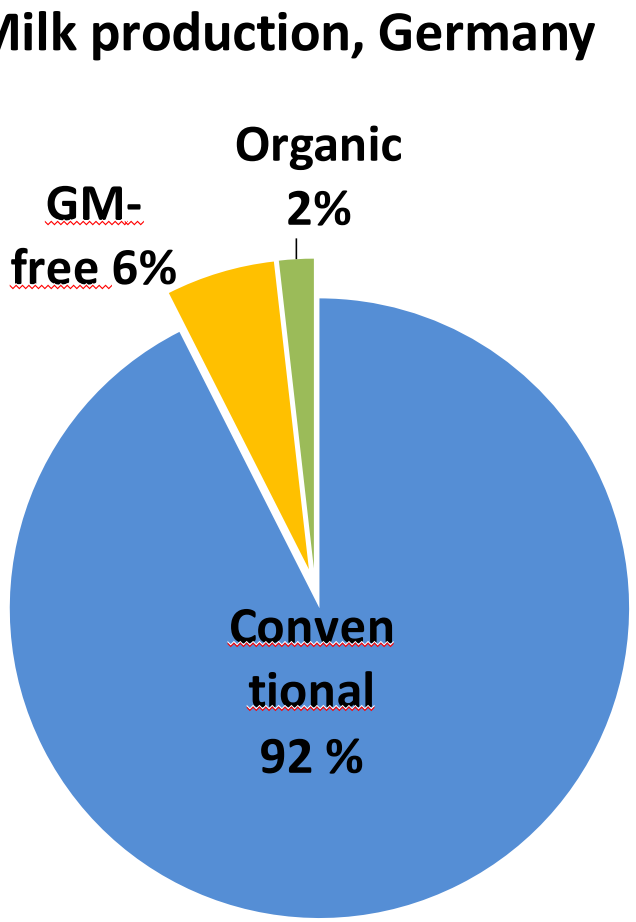
“GM-free” labels



Source: Wesseler, 2012

“GM-free” dairy farms Germany (2010)



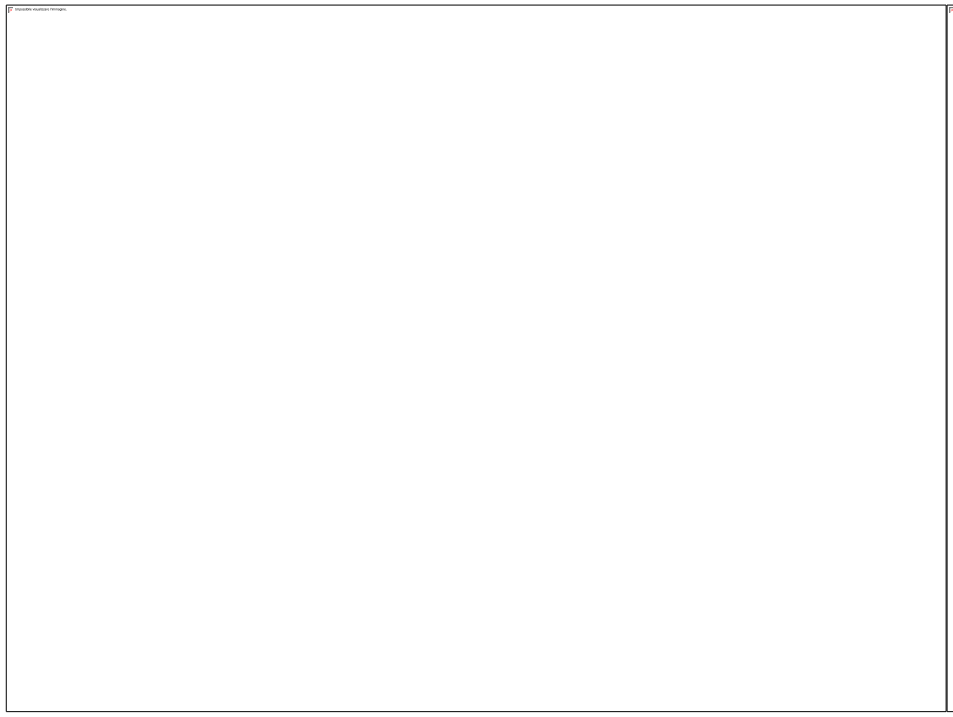


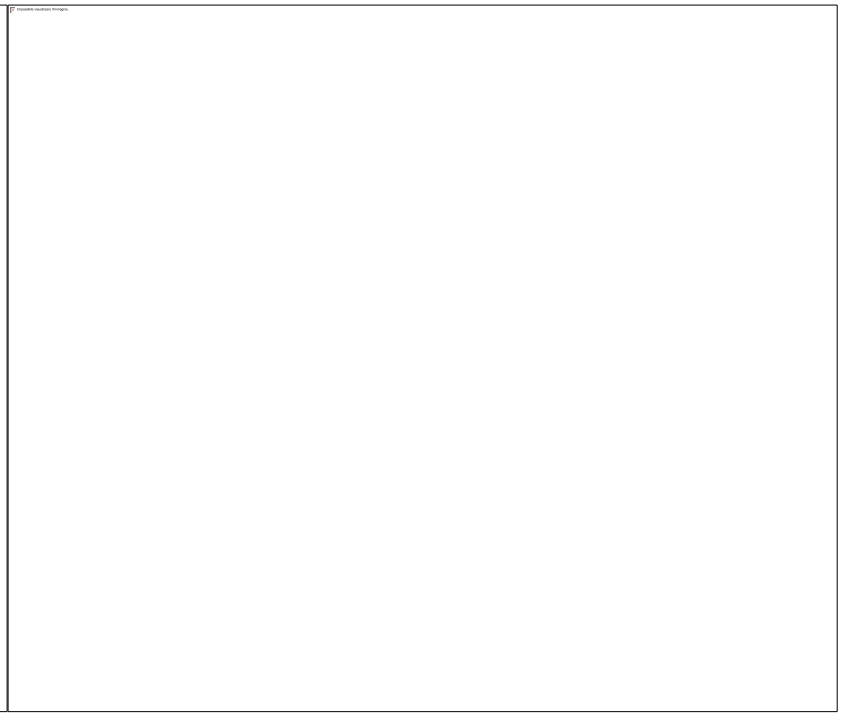
Source: Wesseler, 2012

Opportunities and Threads

- Supply chain management
  - supply of raw material
  - contract design
  - monitoring and enforcement

Supply of raw materials





Source: Danube Soya Initiative, 2014

Contract design

- Raw materials, soy beans in particular
  - Sustainability requirements
  - Long-term contracts (two to three years in advance)
- Production standards for “GM-free””
  - Different standards in the EU
  - Some countries explicit standards, some voluntary
- Liability and redress
- Monitoring and enforcement

Monitoring and enforcement

- External auditors
- Internal certification systems (e.g. EDEKA, Danone Germany)
- New market for certifiers (e.g. CERT Biotech)
- Testing procedures
- Sharing of costs

Opportunities and Threads

- Lobby groups and consumer response
  - importance of lobby groups
  - consumer purchasing behaviour
  - stated vs. revealed preferences

Importance of lobby groups

Vigani and Olper (2014) find not evidence

Consumer purchasing behaviour

- Differences by age
- Differences by income group
- Differences by household structure
- Differences by religion
- Differences by personal characteristics (obesity)
- Differences between regions

Stated vs. revealed preferences

- Substantial differences (e.g. organic market only half the size in Germany)
- Abuse by lobby groups
- Survey design important

Economic Implications

Challenge

Should one introduce a GM free standard based on demands by environmental and consumer lobby groups considering that cultivation of GM crops generates health and environmental benefits while this is dismissed by the lobby groups and if so should those products be labelled and marketed as a contribution to sustainability?

Economic Implications

- Ex-ante vs. ex-post issues
  - Ex-ante regulations
  - Ex-post liability
- Irreversibilities important
- Distribution of benefits and costs over time and space
  - Time: when and how (dynamic)
  - Space: where and who

Economic Implications

Economic Implications

- Retailer response
  - own brand policy
  - firm size and country presence relevant
- Food processors
  - product differentiation
  - complements vs. substitutes

Economic Implications

- Food producers
  - production opportunities
  - compliance issues

EU retailers response: Two Quotes

- Committed to various issues such as stopping the sale of deep sea fish, increasing the range of products certified by the MSC (Marine Stewardship Council) to guarantee sustainable fishing**, excluding GMOs from** all its own-brand products and replacing palm oil or – when this is not possible – ensuring that sustainable palm oil is used.

- Consumer concern over use of GM food ingredients.

  Continue **to label all food containing genetically modified ingredients**. Continue to monitor consumer trends. Consultation with other businesses, governments and industry bodies regarding GM products and undertake further research to gain deeper insight into the issue.

EU retailers response

Country	Companies	2011 retail revenue (USD million)	Countries Present
Austria	1	12498	8
Belgium	3	50232	20
Finland	2	21660	13
France	7	329474	153
Germany	8	373263	106
Italy	3	36455	4
Netherlands	3	60889	19
Portugal	1	5737	10
Spain	2	7783	3
Sweden	2	19260	6
UK	5	185562	24
Total	37	1102813	

Source: Deloitte, 2013

EU retailers response

Country	Companies	Active GM policy	GM+Sust.	Revenue Mio. USD	Revenue Mio. USD	% diff.
Austria	1	1	1	12498	12498	100%
Belgium	3	0	0	50232	0	0%
Finland	2	2	2	21660	21660	100%
France	7	2	2	329474	167798	51%
Germany	8	2	2	373263	104928	28%
Italy	3	1	1	36455	15279	42%
Netherlands	3	1	1	60889	8950	15%
Portugal	1	0	0	5737	5737	100%
Spain	2	0	0	7783	0	0%
Sweden	2	2	2	19260	19260	100%
UK	5	1	0	185562	0	0%
Total	37	11	10	1102813	356110	32.29%

Source: Deloitte, 2013; companies annual reports.

Conclusions

- Modern biotechnology challenges the food sector
- Economic implications substantial
- Sustainability of GM-free labelling strategies questionable
- Distributional impacts significant and ethically difficult to defend

Final Remark

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