Costs and benefits of segregation and traceability between GM and non-GM supply chains and final food/feed products

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Introduction

Introduction

- *Increasing use of GMOs in global agriculture: 125 Mill.* ha in 2008
- *EU: low consumer acceptance of GM foods*
- *Complex regulation of R&D and marketing of GMOs in the agro-food chain*
- *Principle of co-existence between GMOs and non-GM food products established in 2003*
- *Threshold of 0.9 % for labeling of authorized GMOs*
- *Target of the analysis:*
  - *Identify critical points and co-existence measures in different supply chains*
  - *Calculate the costs of such activities*

WP3 partners fields of work

- *Cost calculation*
  - Single crop chains

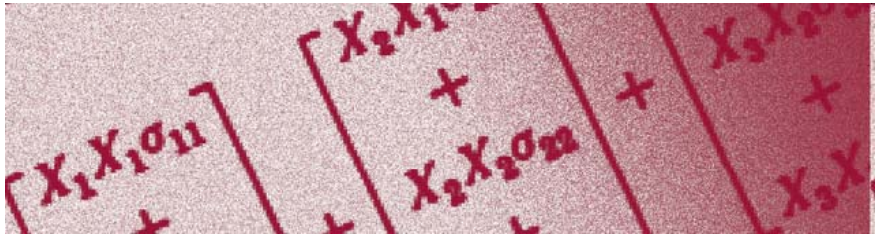
Country / Commodity crop	**Germany** FW, IVV	**Denmark** FOI	**Poland** SGGW/WAU	**Switzerland** FiBL	**Belgium** Hogent
Rapeseed	Oil	Oil	Oil	Oil	---
Wheat	Starch	Flour, feed	---	---	---
Sugar beet	Sugar	Sugar	---	---	---
Maize	Starch	Silage, feed	---	Silage, feed	---
Soy	---	Feed	---	---	Feed

  - Complex food/feed

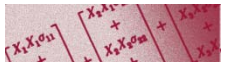
Germany FW, IVV	Frozen pizza Chocolate (bar)
Denmark, FOI	Compound feed
Belgium, Hogent	

Source: own presentation

Methodology

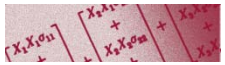


2. Methodology



Model methodology and data

- *Developing a universally adaptable calculation model for all supply chains and applications (food/feed)*
- *Cost accounts and calculation methodology based on results of WP2 (supply chain structure and critical points)*
- *Quantitative and qualitative data gathered from stakeholder interviews and existing published data sources*
- *Partially assumptions on meaningful data had to be used to bridge data gaps*
- *Principles of the model:*
  - *Supply chain from seed to end-use food product covered in the model*
  - *Different cost types are calculated on each level of the value chain and resulting costs are transferred to next level via increased commodity prices for non-GM products*
  - *Individual case-sensitive factors used in the calculation (GM pressure, acreage, production volumes, yields, capacities, product prizes…)*

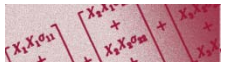


„Adjusting screws“ of the model

- Seed Production
- Farm Production
- Elevator
- Milling
- Wheat Starch Processor
- Trade
- Consumer

- Legally set GM-threshold in products
- Regional GM-adoption rate
- Seed/commodity- import situation
- GM- benefits (yield, crop growing)
- On-field prevention management to avoid cross-pollination
- Additional field testing strategy
- Storage/transport-responsibility
- …

- Import situation (risk management)
- Application (Food/Feed)
- Legally set GM-threshold in products
- Separating strategy of processing
- Share GM-processing
- Transport and hygiene management
- Testing management
- …

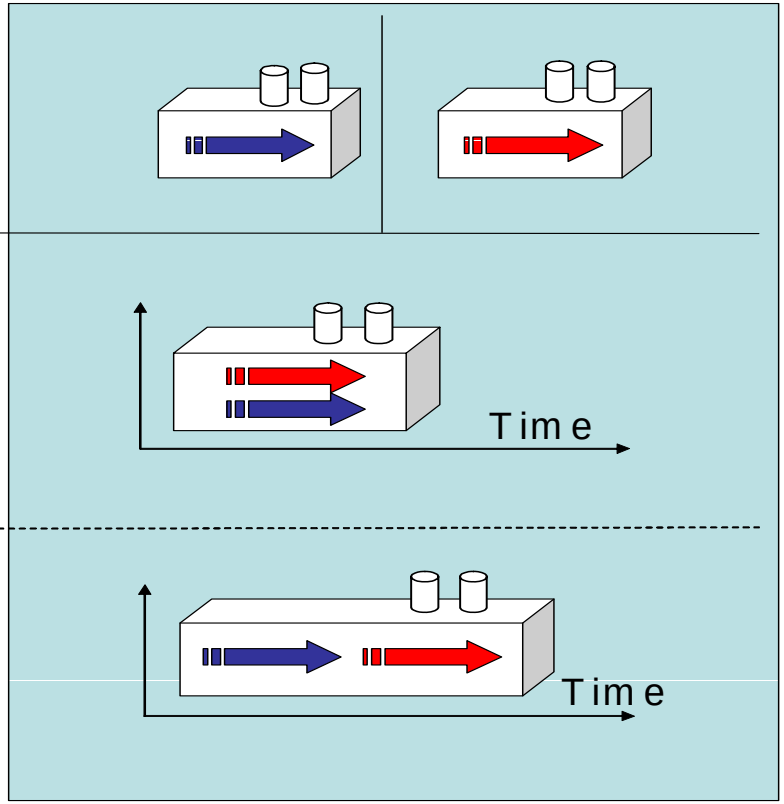


Segregation strategies in processing

1) Segregation : The 2 types of production are separated in two different factories/association with a competitor

2) Spatial specialisation : lines are dedicated to one type of products
A- Partial : equipment non dedicated
B- Total : equipment dedicated

3) Temporal specialisation : lines are dedicated to one type of products
A- Stop and cleaning
B- Cleaning with products



Excel-based cost calculation model: "Single supply chains"

- *Cost type identification at processing levels*

	A	B	C	D	E	F	G
1	**Supply Chain: Wheat**			(Wheat Seed - Wheat - Wheat (purified) - Wheat starch - -)			
2	Set-up 1: Regional cultivated GM-wheat						
3							
4	**Product**	**Supply chain level**	**Activated**	**Prevention costs**	**Unit**	***Share***	**GMO-Risk**
31		**Total additional prevention costs per unit**		**10,26**	**€/t**		
32							
33							
34		**Elevator - E**					
35	***Wheat (purified)***	A. Addinional commodity costs	Yes	6,64	€/t	*91,1%*	
36		B. Testing costs	Yes	0,65	€/t	*8,9%*	
37		C. Depriciation of add. storage	No	---	€/t	—	
38		D. Cleaning/Flushing costs	No	---	€/t	—	High
39		E. Possible add. transport costs	No	---	€/t	—	
40		F. Miscellaneous costs	No	---	€/t	—	
41		**Total prevention costs**		**7,28**	**€/t**	***100,0%***	
42							
43							
44							
45		**Crusher - C**					
46	***Wheat starch***	A. Additional commodity costs	Yes	11,00	€/t	*56,6%*	
47		B. Testing costs	Yes	8,44	€/t	*43,4%*	
48		C. Depriciation of add. storage	No	---	€/t	—	
49		D. Cleaning/Flushing costs	No	---	€/t	—	Medium
50		E. Production stop costs	No	---	€/t	—	
51		F. Education and training	No	---	€/t	—	
52		G. Miscellaneous costs	No	---	€/t	—	
53		**Total prevention costs**		**19,44**	**€/t**	***100,0%***	
54							

Farm level | Elevator | Crusher (Mill) | Processor | Summary

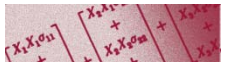
Excel-based cost calculation model: "Single supply chains"

- *Calculated results*

	A	B	C	D	E	F	G
	Supply Chain: Wheat			(Wheat Seed - Wheat - Wheat (purified) - Wheat starch			
	Set-up 1: Regional cultivated GM-wheat						
	Product	**Supply chain level**	**Activated**	**Prevention costs**	**Unit**	***Share***	**GMO-Risk**
		Total Chain					
		GMO-Risk		High			
		Total number of activated accounts		**9 / 37**			
		Total prevention costs:					
	Wheat	*Farming level - F*		*10,26*	€/t		
	Wheat (purified)	*Elevator - E*		*7,28*	€/t	*+4,41%*	
	Wheat starch	*Crusher - C*		*19,44*	€/t	*+6,22%*	
	-	*Processor - P*		—	€/t	*+0%*	

- Responsibility for implementing co-existence measures (e.g. storage/transport, monitoring) is influenced by the chain management system of the respective supply chain
- Total prevention costs at each level transferred to the following supply chain level by extra commodity costs (higher commodity prices)

=> The price loading at the final actor level describes the overall costs of all whole-chain co-existence measures using a certain separating strategy



Excel-based cost calculation model: "Compound food/feed chains"

- *Cost types identification (example: frozen pizza)*

I. Product-related costs:
B0. Output testing
C0. Depriciation of add. storage
D0. Cleaning costs
E0. Production stop costs
F0. Education and Training
G0. Miscellaneous costs

↔

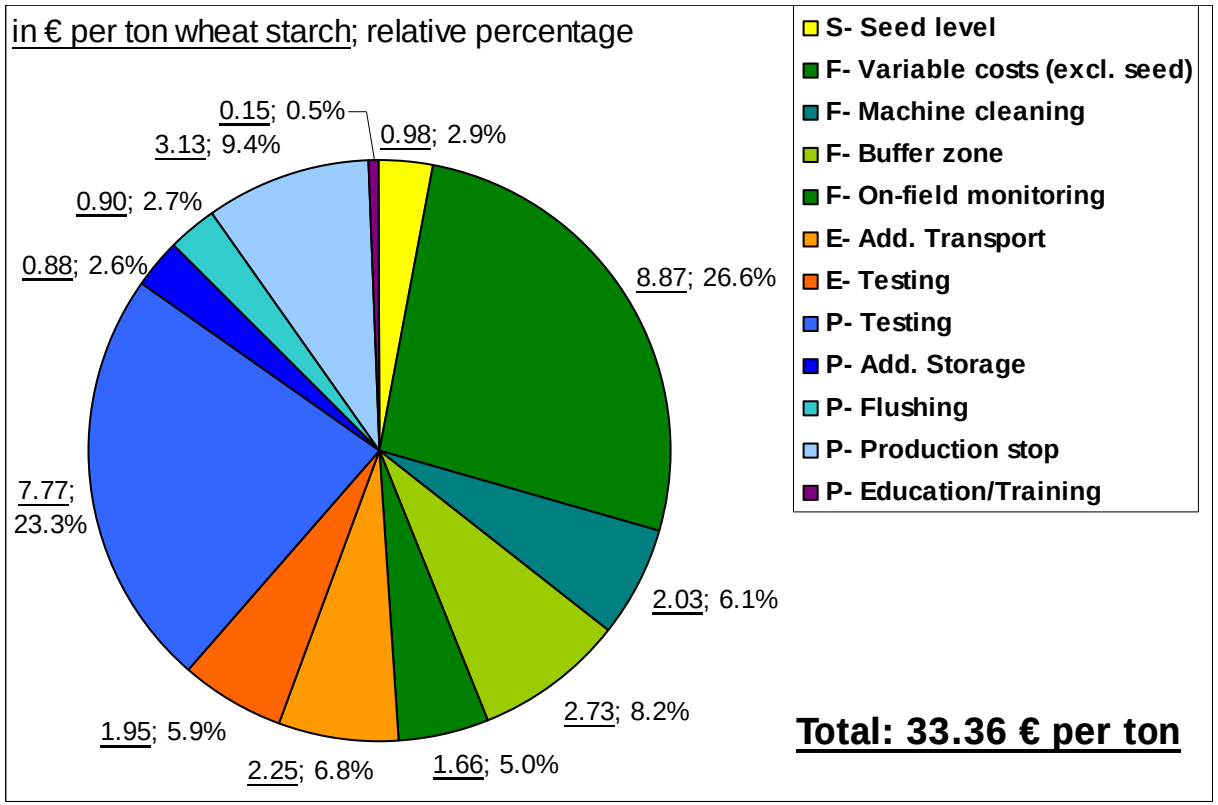
II. Commodity-related costs:
Ingr. 1: Rapeseed Oil
A1. Commodity & extra transport
B1. Input testing
C1. Depriciation of add. storage
D2. Cleaning costs
G1. Miscellaneous costs
Ingr. 2: Wheat flour
A2. Commodity & extra transport
B2. Input testing
C2. Depriciation of add. storage
D2. Cleaning costs
G2. Miscellaneous costs
Ingr. 3: Modified maize starch
A3. Commodity & extra transport
B3. Input testing

Results

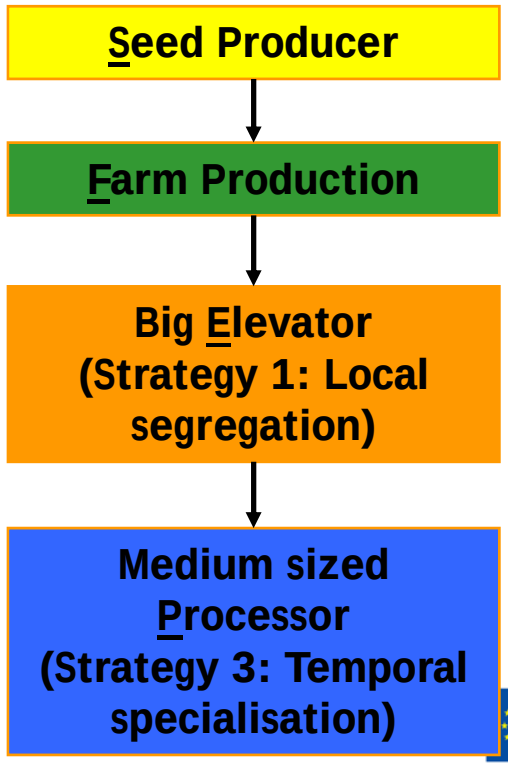
2. Results: Single supply chains

Wheat starch supply chain: Germany

- *Cost allocation for wheat starch supply chain*



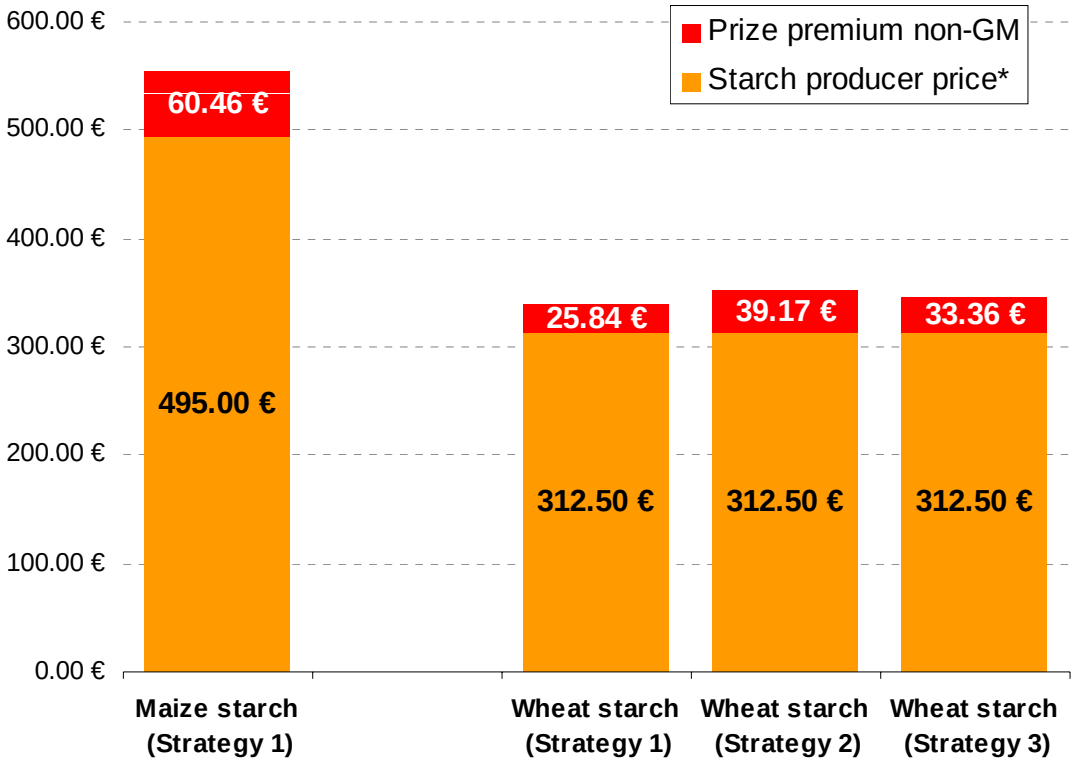
Source: Own calculations



2. Results: Single supply chains

Starch supply chain: Germany

- *Comparison of co-existence costs in different starch supply chains (maize and wheat)*
  - Extent of price premium of non-GM starch products

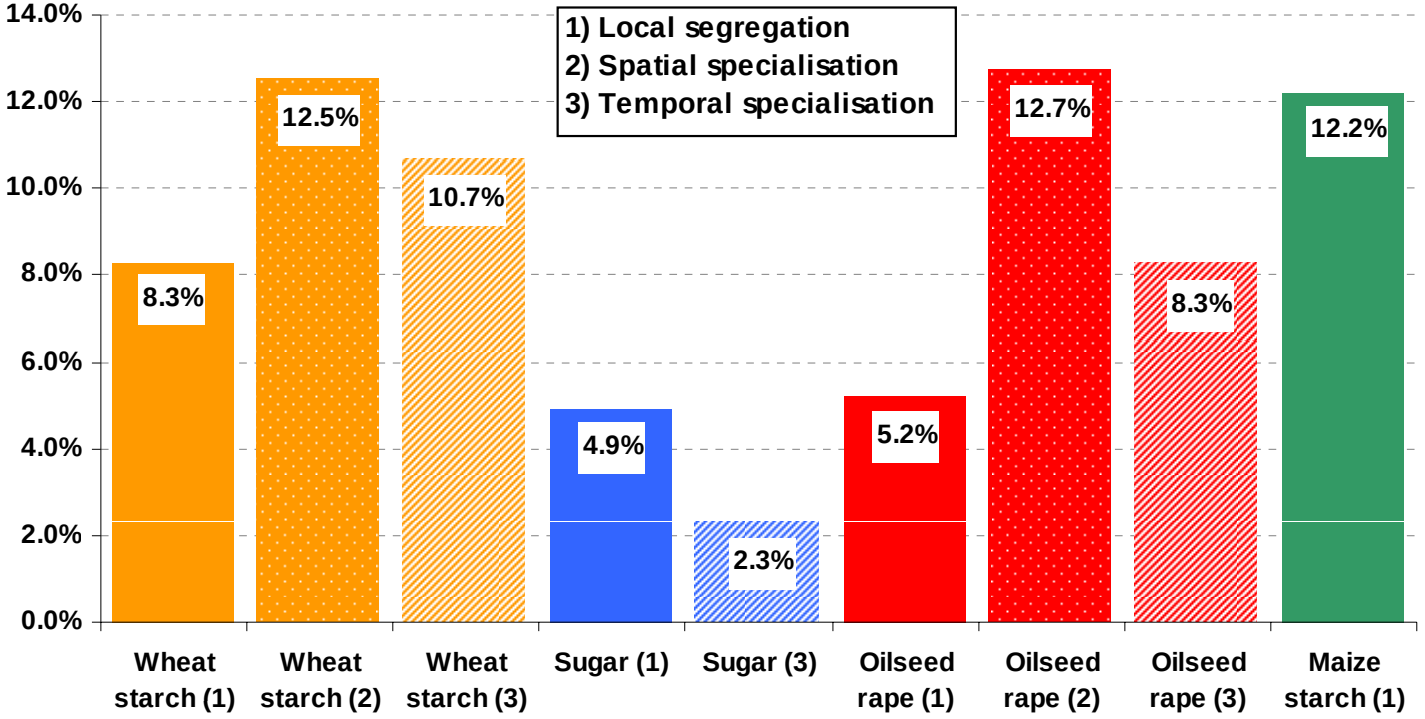


Source: Own calculations; *Prices interpreted by interviews 2006
Strategy 1= Local segregation; Strategy 2= Spatial specialisation; Strategy 3= Temporal specialisation

2. Results: Single supply chains

Supply chain comparison: Germany

- *Additional costs for non-GM food production in the considered supply chains* in a 50% GM scenario
  - depending on applied segregation strategy
  - in % of whole product turnover



Source: Own calculations

Cross-national comparison: sugar

- *Different basic set-ups for German and Danish sugar supply chain can cause deviant results for the country calculations*

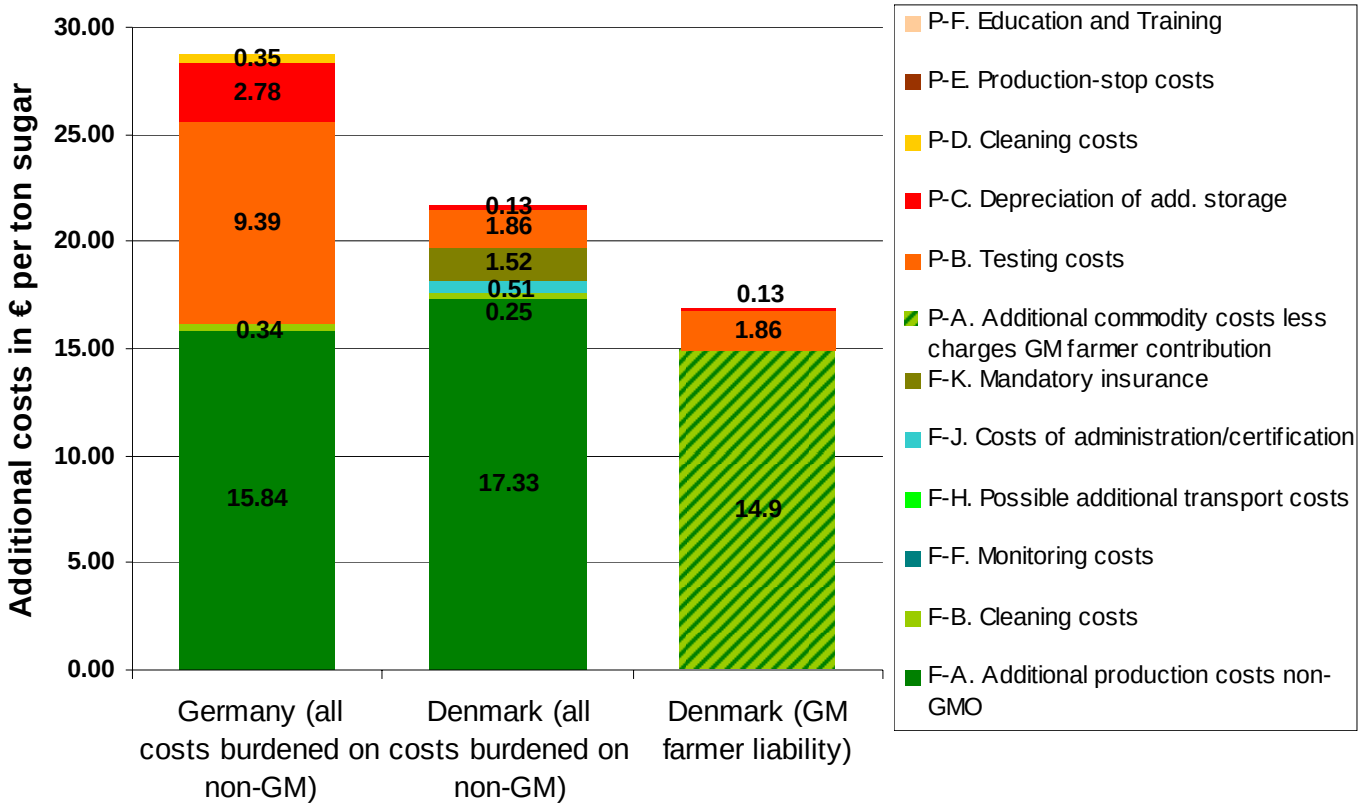
Country	Denmark	Germany
Set up farm level (sugar beets)		
GM sugar beet	H7-1 (Roundup-resistant)	H7-1 (Roundup-resistant)
GM adoption rate in region	50 %	50 %
Assumed threshold for non-GM seed	---	0.3 %
Extra costs non-GM seeds	---	8.1 %
Extra costs GM seeds	33 €	17.5 %
Yield	57 tons	60 tons
Average crop area	6.2	9.3
Perceived benefits	Cost reduction pesticides Cost reduction machinery	Lower production costs Higher yield (5 %)
Selling price GM (2007)	26.3 €	32.90 € (2006-2007)
Set-ups sugar processor level		
Company	Danisco A/S	Anonymous
Annual amount of beets	2,800,000 tons	1,100,000 tons
Annual amount of sugar	421,000 tons	150,000 tons
Sugar content in beet	~ 15 %	~ 15 %
GM adoption rate	50 %	50 %
Preferred strategy	Time separation	Time separation

Differences depending on:

- national preconditions
- literature sources
- reference companies/farm sites
- different assumptions
- ...

Cross-national comparison: sugar

- *Allocation of additional co-existence costs in Germany and Denmark*



2. Results: Single supply chains

Cross-national comparison

- *Costs of co-existence and traceability of rapeseed oil production: Crusher level*

Country	Germany	Denmark	Poland	Switzerland
Joint preconditions	■ 50 % regional GM adoption rate ■ Accepted non-GM price premium from the farm/elevator level ■ Products for human consumption and food industry ■ Processing strategy: **temporal specialisation**			
Individual assumptions	■ Processing capacity 600.000 tons rapeseed per year ■ Share GM commodity: 30 % ■ Price premium non-GM rapeseed: 4.6 % ■ Restriction to input testing ■ Strategy requirements: Additional storage capacities, flushing and production stop, personnel education	■ Processing capacity 90.000 tons rapeseed per year ■ Share GM commodity: 20 % ■ Price premium non-GM rapeseed: 11 % ■ Restriction to input testing ■ Strategy requirements: additional storage capacities and production stop costs due to changeover	■ Processing capacity 400.000 tons rapeseed per year ■ Share GM commodity: 50 % ■ Price premium non-GM rapeseed: 6.1 % ■ Restriction to input testing ■ Strategy requirements: cleaning, personnel education, auditing (all efforts here economical insignificant)	■ Processing capacity c.a. 150.000 tons rapeseed per year ■ Share GM commodity: 20 % ■ Price premium non-GM rapeseed: 17.4 % (incl. IP) ■ Restriction to output testing ■ Strategy requirements: cleaning/flushing efforts
Total additional costs	■ **74.10 € per ton** ■ **8.3 % of turnover**	■ **83.16 € per ton** ■ **8.3 % of turnover**	■ **21.6 € per ton** ■ **3.6 % of turnover**	■ **106.98 € per ton** ■ **5.3 % of turnover**

2. Results: Single supply chains

Cross-supply chain comparison

- *Costs of co-existence and traceability of wheat products at the end of the analysed supply chains*

Processor	Germany						Denmark					
Product	Wheat Starch		Wheat Starch		Wheat starch		Compound Feed (+soy)		Compound Feed (+soy)		Flour and bran	
Strategy	Local segr.		Spatial sp.		Temporal sp.		Local segr.		Temporal sp.		Temporal sp.	
Cost types	Costs (€/t)	%	Costs (€/t)	%	Costs (€/t)	%	Costs (€/t)	%	Costs (€/t)	%	Costs (€/t)	%
P-A	24.28	*94.0*	20.53	*52.4*	20.53	*61.4*	5.68	*41.4*	6.77	*39.1*	8.84	*82.8*
P-B	1.51	*5.8*	7.77	*19,8*	7.77	*23.3*	0.39	*2.8*	0.39	*2.3*	0.38	*3.6*
P-C	--	--	0.88	*2,3*	0.88	*2.6*	--	--	---	---	1.20	*11.2*
P-D	--	--	--	--	0.90	*2.7*	--	--	0.05	*0.3*	---	---
P-E	--	--	--	--	3.13	*9.4*	--	--	1.80	*10.4*	---	---
P-F	0.05	*0.2*	0.1	*0.3*	0.15	*0.4*	--	--	---	---	---	---
P-G	--	--	9.89	*25.3*	--	--	7.92	*55.9*	8.28	*47.9*	0.26	*2.4*
Total	**25.84**		**39.17**		**33.36**		**14.17**		**17.29**		**10.68**	

P-A: Commodity & transport, P-B: Monitoring, P-C: Additional storage, P-D: Flushing, P-E: Production stop, P-F: Education & training, P-G: Miscellaneous (e. g. investment costs for a secondary production line)

Overview of the structure and segregation strategies of the reference chocolate company

Company structure	
Product focussing	Own and trading brands, preproduction
Product	Unfilled chocolate bars
Share GM products	50%
Plant sites	2 plants in same region (production capacities: 2 * 40.000 tons per year)
Employees	750
Wholesale price	3.40 €/kg
Product turnover	272,000,000 €

Relevant ingredients (concerning GM issues):		**Prize loading non-GM**
- Sugar	46% (non-GM: 18,400 tons)	+ 2.6 % (WP3 Sugar chain report)
- Lecithin	0.3% (non-GM: 120 tons)	+ 50% (Survey 2005)
- Vegetable fats and oils (e.g. cocoa, soy, rapeseed, palm etc.)	18% (non-GM: 7,200 tons)	+10 % (Assumed prize)*
Commodity origin	Only EU regions, no import from overseas markets	

Testing strategy (only input testing on GM production site)	
GM analysis	External laboratory
Test type	Qualitative PCR-Tests
Frequency	Totally around 174 tests per year
Mean testing costs	190 € per test (incl. labour, laboratory etc.)

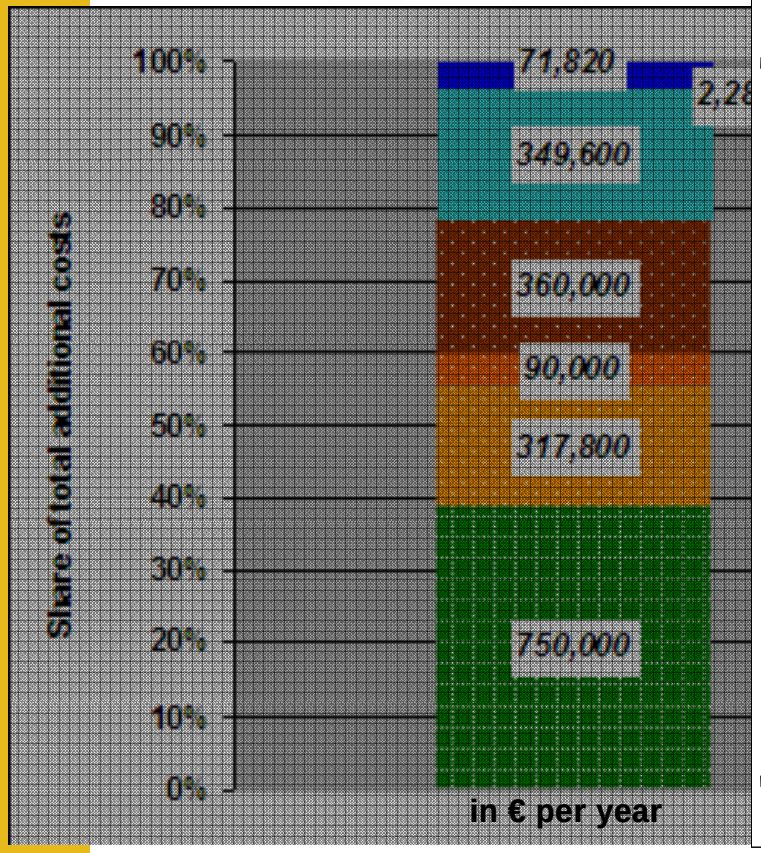
Additional labour efforts	
Training, education and additional staff	2-3% of product turnover

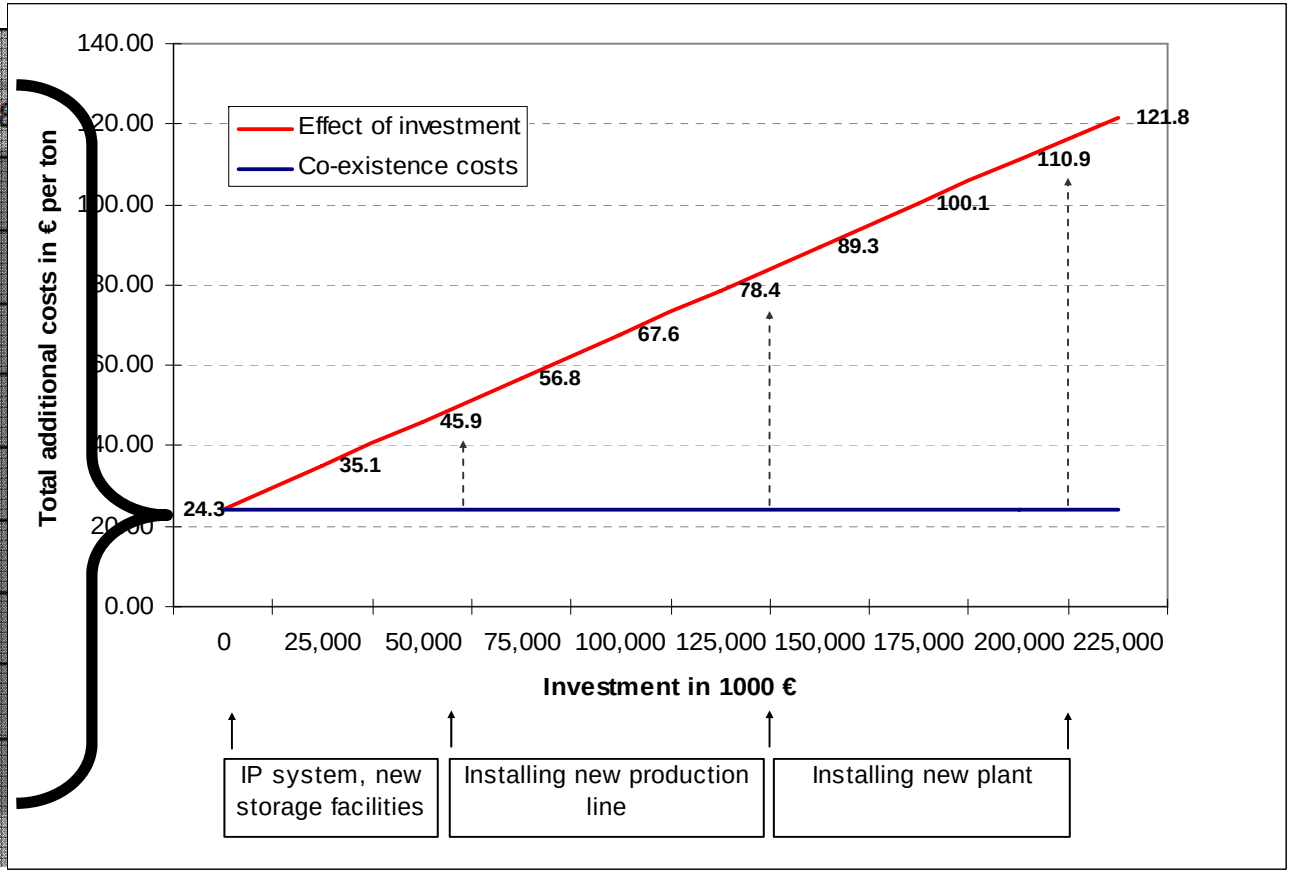
Assumed production separation strategies	**Situation I.: Local segregation (two existing sites)** **Situation II.: Local segregation (New 2nd site, heavy investment)**

2. Results: Complex food/feed

Cost of co-existence and segregation for chocolate industry in Germany

- *Allocation of additional costs and the effect of investment*





Source: Own calculations

Characteristics of compound feed production

- *High volume throughput with small margins per unit*
- *Use of a variety of raw materials / ingredients*
- *Large number of different products (various recipes)*
- *Frequent change between different recipes*
- *High flexibility, close to "just in time" production*
- *Most factories certified by external certifications bodies*
- *Have been handling GM/non-GM production for a long period because of a market demand*

Segregation / Prevention Costs

Feed producer	Poland		Denmark		Belgium	
A. Additional commodity costs	5.31 €/t	*67.8 %*	15.83 €/t	*76.1 %*	2.63 €/t	*51.6 %*
B. Testing costs	0.64 €/t	*8.2 %*	0.02 €/t	*0.1 %*	0.21€/t	*3.5 %*
C. Depreciation of add. storage	---	---	---	---	---	---
D. Cleaning/Flushing costs	0.89 €/t	*11.4 %*	1.14 €/t	*5.5 %*	0.90 €/t	*16.1 %*
E. Production stop costs	---	---	3.8 €/t	*18.3 %*	---	---
F. Education and training	0.28 €/t	*3.6 %*	---	---	0.14 €/t	*2.0 %*
G. Miscellaneous costs	0.71 €/t	*9.04 %*	---	---	1.65 €/t	*26.8 %*
Total prevention costs	**7.83 €/t**		**20.79 €/t**		**5.54 €/t**	

Source: Own calculations

- *Compound feed producer*
  - *Additional "technical costs": 2,5 €/ton (PL), 3 €/ton (BE), 5 €/ton (DK)*
  - *Additional raw material costs depend on the recipe (varies from 52% to 76%)*

Recommendations and conclusions

Conclusions for costs

- *Significant additional costs are to be expected by the implementation of co-existence strategies in EU agro-food supply chain*
- *Cost level depends on multiple factors (like e.g. crop requirements, farming systems, storage and elevating systems, processing strategies, monitoring management) and can only be calculated on a case-by-case basis*
- *Flexible handling of co-existence rules strongly recommended in order to allow actors in a specific value chain to choose a cost-effective co-existence strategy*
- *Cost savings expected in future in case co-existence systems are permanently operating*

4. Conclusion

Conclusions for stakeholders

- *EU consumers most likely are not willing to pay the* extra costs for product differentiation (i.e. labelled food product that contains GM materials below the threshold of 0.9%) since this system does not offer clear benefits for the consumer

- Co-existence and labelling systems for maintaining the GMO threshold of 0.9% hardly bears any additional benefits for producers nor retailers

- No actor of the value chain might be willing to pay the incurred costs of co-existence measures occurring in the respective supply chain by himself