COSTS OF CO-EXISTENCE AND TRACEABILITY SYSTEMS IN THE FOOD INDUSTRY IN GERMANY AND DENMARK

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Costs of co-existence and traceability systems in the food industry in Germany and Denmark

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Abstract:

This paper quantifies the cost of traceability and co-existence systems for GM food from the seed to the processing level for sugar, wheat starch and rapeseed oil for human consumption in Germany and Denmark respecting the 0.9 % threshold for labelling of GM food. The cost calculations for traceability and co-existence measures are done with a specifically developed simulation model. Together, the considered co-existence measures lead to an 8 % higher price for GMO-free rapeseed oil, 2 - 5 % higher prices of GM-free sugar and to a 5 - 12 % price increase for different non-GM wheat products.

1. Introduction

The worldwide acreage of genetically modified (GM) plants is growing year by year and amounted to 125 million ha in 2008 with more than 13 million farmers in 25 countries growing mainly GM soybean, GM maize, GM cotton and GM rapeseed (ISAAA 2008). It is important to consider that the EU imports around 40 million tons of soybeans mainly from USA and Latin America, of which the main part is GM (Transgen 2007b). In contrast to the globally fast-growing penetration of GM crops in particular in Northern and Latin America, Bt-maize which is resistant to certain lepidopteran pests, is the only GM crop that is commercially grown in the EU. In 2007, GM maize was cultivated on 75,000 ha in Spain representing around one quarter of the production of maize in this country (GMO Compass 2007, ISAAA 2007). According to listings in site registers, GM maize was grown in four additional EU member states (France, Czech Republic, Portugal and Germany) in 2007. Altogether, the nearly 110,000 ha of GM maize commercially grown in the EU in 2007 represent around 1 % of the total maize cultivation area (GMO Compass 2007).

In contrast to the increasing use of GM plants in world-wide agriculture, the acceptance of GM food is still low in the EU (Gaskell et al. 2006, Costa Font et al. 2008). In order to deal with the opposition of EU consumers and several member states, the EU adopted a series of regulations related to genetically modified organisms (GMOs) of which the regulations (EC) No 1829/2003 and 1830/2003 (dealing with the admission, labelling and traceability of GMOs) have special impact on the food and feed industry (Jany and Schuh 2005). Important targets of these regulations are to ensure freedom of choice for consumers and users of GM and non-GM products as well as to avoid environmental and health risks associated with the commercial use of GM products. According to regulations (EC) No 1829/2003 and 1830/2003, food and feed products have to be labelled to contain EU authorized GMOs or GM material. Products containing traces of GMOs below the appropriate regulatory thresholds (0.9 % GM material for GMOs which are approved in the EU) are exempted from labelling provided that compliant traceability systems are in place and traces of GMOs are adventitious and technically unavoidable. Animal food products, which were produced with GM feed compounds, also do not have to be labelled. Products containing GMOs (above the threshold) must be labelled as such, even when the GM material is undetectable by analytical tests (Fagan 2004, European Parliament and the Council of the European Union 2003a, b).

At least since the beginning of this century, there is an intensive discussion how to ensure freedom of choice between farmers with differing agricultural production systems within the EU – as well as for consumers who might be willing to buy and consume GM foods or not. In July 2003, the European Commission released Commission Recommendation 2003/556/EC which defined general co-existence guidelines. Additionally, the European Commission asked member states to set up national strategies and best practices to ensure the co-existence of GM crops with conventional and organic farming. Several studies analysed the possibilities of co-existence schemes and their economic effects on crop production in Europe (e. g. Bock et al. 2002, Tolstrup et al. 2003, Messéan et al. 2006). Additionally, the EU financed SIGMEA project analysed a broad range of issues related to co-existence on the farming level (Messéan et al. 2009), but important questions (e.g. the threshold level of GM adventitious presence in EU seed production) are still outstanding and the subject of on-going intensive discussions.

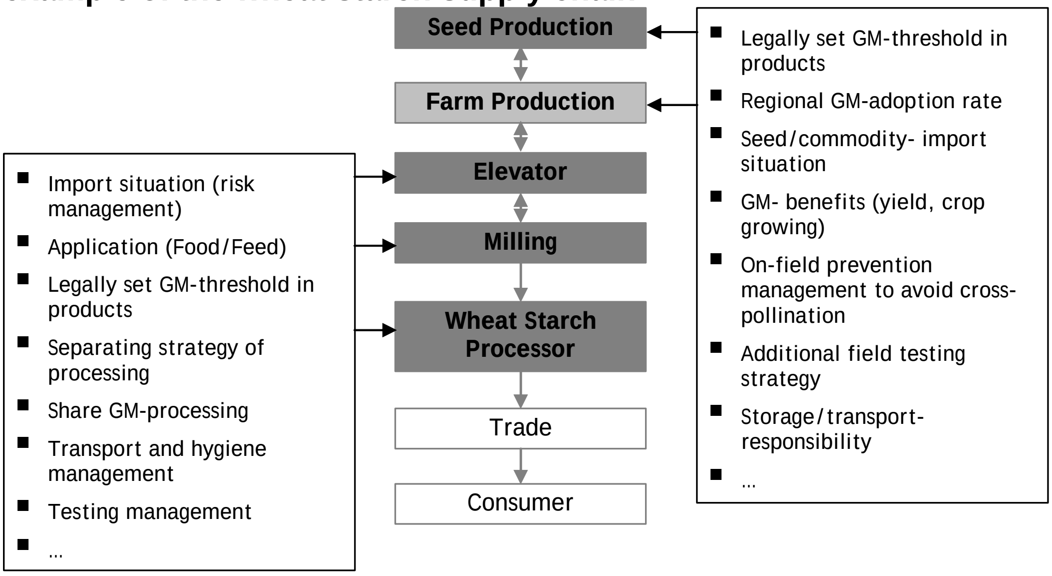
Due to the low consumer acceptance in most of the EU member states, the German food industry has taken a “wait and see”-position with respect to introducing GM food which needs to be labelled (Hirzinger and Menrad 2007). With the exception of a few EU member states (e.g. the Netherlands), hardly any GM food can be found on retail shelves of the EU (Transgen 2007a). Against this background we analysed which measures the producers of food products in Germany and Denmark and the suppliers of commodities for these products have to apply to adhere to the specifications of the regulations (EC) No 1829/2003 and 1830/2003 for labelling and traceability of GMO. In addition, the costs of segregation and traceability systems in the different considered supply chains were identified, quantified and evaluated for selected value chains.

2. Methodology

In order to quantify the co-existence costs of selected supply chains, a universally adaptable MS Excel-based calculation model was developed. This model allows a flexible and individual composition of strategy-relevant cost types on all levels of the supply chain and additionally respects significance of case-sensitive factors like GM pressure, crop acreage, products volume, prizes, etc. Quantitative and qualitative data was gathered from stakeholder interviews and existing published data sources. The model permits concrete results of additional costs and a well-arranged documentation of cost allocation along the supply chains.

All levels of the analysed single crop-value chains sugar (beet), rapeseed oil, wheat (starch for Germany, flour and use in animal feed for Denmark) were taken into account in order to comply with the relevant EU regulations. While domestic parts of the value chains are included in the cost calculations, imports and exports of e. g. crops, animal feed material or processed products are excluded in the cost calculations as well as the situation in the food retail shops and in the home of the consumers mainly due to the lack of existing data (figure 1). The measures to ensure traceability of non-GM commodities and food are analysed individually for the different value chains. Production/processing prerequisites and critical points along the supply chain have a strong impact on the particular cost structure of a value chain. Therefore, experts’ statements and stakeholders’ opinions were used to identify additional cost types in the emerging case of co-existence.

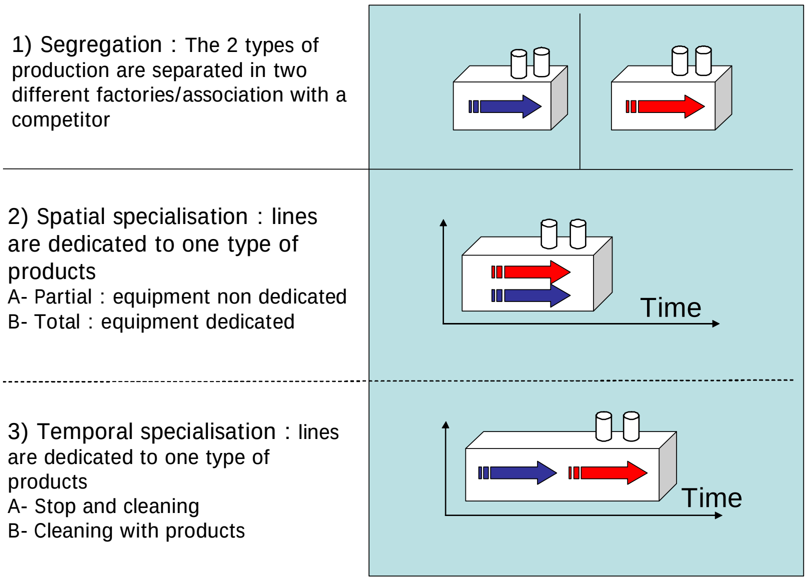
Figure 1: Supply chain levels and „adjusting screws“ of the model along the example of the wheat starch supply chain



The calculation of costs for traceability and co-existence measures at each level of the value chain follows the principle to aggregate all incurred costs for cultivation and transportation of crops or processing of the raw material crops on the different levels and to increase the price of the final product at each level. This means that e. g. the commodity price of wheat is increased by the costs of co-existence measures on the farm level in order to comply with the threshold of 0.9 % for adventitious presence of GM material. The resulting price for secured non-GM wheat is automatically the non-GM commodity price in the next level of the value chain, while the price of GM commodity represents the current price level without any co-existence and traceability measures. This principle is used at all stages of the supply chain, thus aggregating the additional costs on all levels and setting the price for the non-GM product at the end of the value chain. In general, the additional co-existence and traceability costs are referring only to the final food product of the value chain and do not consider any by-products. In order to ensure co-existence (on defined thresholds) between GM and non-GM crops and products along the supply chains, concrete measures and “adjustment screws” have been taken into account from seed to processor level. These adjustment screws represent different cost types and applied measures respecting individual case-sensitive factors used in the calculation (figure 1).

On processing levels (elevator, crusher, processor), the composition of occurring cost types is strongly oriented on the considered processing strategy. Depending on several preconditions (e. g. capacities, size, and location factor) and parameters (e. g. regulatory framework, co-existence situation, and company’s overall concept), each involved actor has to choose its own strategy. Figure 2 shows the three strategies that are simulated for the calculation analyses.

Figure 2: Possible strategies to manage co-existence in the food processing industry



Source: Hirzinger 2008

3. Results of cost analyses

3.1 Wheat supply chain

All the identified and charged cost types of the analysed wheat chains (starch, feed, flour) in Germany and Denmark are compared with each other whereby the calculated costs are discussed on the different levels of the value chain.

Seed level

Actually, there are no empirical valid data sources of additional costs for avoiding GM and non-GM wheat admixture at the seed producer level in both countries. Therefore, it was assumed that the cultivation and harvesting of wheat seed is quite similar to that at the farm level taking into account some additional cleaning requirements of machinery and specific isolation distances between seed-producing fields. Due to the (still assumed) lower GM-threshold of wheat seed compared to the farm level, the pureness of the seeds is one of the most important factors for the co-existence of GM and non-GM wheat at farm level (Tolstrup et al. 2003).

In order to get a concrete figure for the calculation of the co-existence and traceability costs for producing non-GM wheat seed with a certain GM-threshold, the data of the Danish DIAS report (Tolstrup et al. 2003) were used, which analyses the extra costs of separating non-GM and GM phytase wheat seeds. Tolstrup et al. 2003 assumed that the higher costs for non-GM wheat seed amount to 1.4 % of the total variable growing costs. These costs are also the total non-GM seed production costs in the case of co-existence. The seed prices for GM seed depend strongly on the benefit of the variety, yields and the seed breeding and growing costs as well as a technology fee set by the breeder of the GM variety. Thus, the price premium for the non-GM seed was estimated based on the seed costs on farm level.

Farming

The comparison of the two country studies shows the strong sensitivity of the results depending on the considered general farming conditions, variety's benefit and the selected cost types (table 1).

Table 1: Comparison of the German and Danish cost structure for producing non-GM wheat at farm level

Farm level	**Germany**		**Denmark**	
Regional GM-adoption	**50 %**		**50 %**	
Cost types	Costs (€/ha)	*%*	Costs (€/ha)	*%*
F-A: Production costs	51.77	*60.5*	34.44	*89.6*
F-B: Machine cleaning	10.72	*12.5*	--	--
F-C: Time isolation	--	--	--	--
F-D: Discard width	--	--	--	--
F-E: GM buffer zone	14.34	*16.8*	--	--
F-F: Monitoring	8.75	*10.2*	4.00	*10.4*
F-G: Additional storage	--	--	--	--
F-H: Additional transport	--	--	--	--
F-J: Administration/certification	--	--	--	--
F-K: Miscellaneous	--	--	--	--
Total (€ per ha)	**85.58**		**38.44**	
in € per ton wheat	**10.85**		**4.87**	

Source: Own calculations within the EU FP6 CoExtra project

The total co-existence costs for the German farm level are estimated with 85.58 € per ha, more than twice that as in Denmark. These different results emerge from differing approaches and assumptions:

- Different on-field monitoring strategies varying in testing strategy and intensity (Danish assumption: one strip test per ha; Germany: 1.5 % of the total variable costs are related to on-field monitoring).
- In the German calculations, a reduction of the gross margin is considered due to the isolation of GM and non-GM fields with buffer zones, while this cost type is not considered in the Danish study. The quantification of the costs of buffer zones can result in a large range of differing costs (Menrad and Reitmeier 2008).
- According to the available data structure and calculation approach, some costs can occur in different cost types of the model. While the cleaning costs of machinery and transportation are pointed out in a single cost type in the German part (see table 1, F.-B), the Danish study integrates them into the production costs (see table 1F-A).

Elevator

Lower co-existence costs in the Danish bread quality wheat chain result from the current farming system of growing bread quality wheat in Denmark. It is assumed that wheat for human consumption produced in Denmark is always grown on contract and stored at the farm site. Farmers supplying the elevators with bread quality wheat have already special storage facilities for the wheat. Thus, wheat used for human consumption never physically enters the elevators in Denmark. Table 2 shows quite homogeneous results for the elevator level with regard to the different wheat processing chains and strategies.

Table 2: Comparison of the German and Danish cost structure for producing non-GM wheat at elevator level

Elevator level	Germany				Denmark					
Product	**Wheat for Starch**		**Wheat for Starch**		**Wheat for Feed**		**Wheat for Feed**		**Wheat Bread Quality**	
Strategy	Local segr.		Temporal sp.		Temporal sp.[1]		Local segr.		Local segr.	
Cost types	Costs (€/t)	*Share*	Costs (€/t)	*Share*	Costs (€/t)	*Share*	Costs (€/t)	*Share*	Costs (€/t)	*Share*
E-A: Commodity & transport	12.35	*90.5*	10.95	*68.1*	11.51	*98.2*	11.21	*82.2*	6.73	*97.3*
E-B: Monitoring	1.30	*9,5*	2.62	*16.3*	0.21	*1.8*	0.75	*5.5*	0.18	*2.7*
E-C: Add. storage	--	--	1.58	*10.4*	--	--	--	--	--	--
E-D: Flushing	--	--	0.02	*0.1*	--	--	--	--	--	--
E-E: Add. transport	--	--	0.32	*2.0*	--	--	--	--	--	--
E-F: Miscellaneous	--	--	0.50	*3.1*	--	--	1.58	*11.7*	--	--
Total	**13.65**		**16.09**		**11.72**		**13.55**		**6.91**	
E-A: Commodity & transport, E-B: Monitoring, E-C: Additional storage, E-D: Flushing, E-E: Additional transport, E-F: Miscellaneous										

Source: Own calculations within the EU FP6 CoExtra project

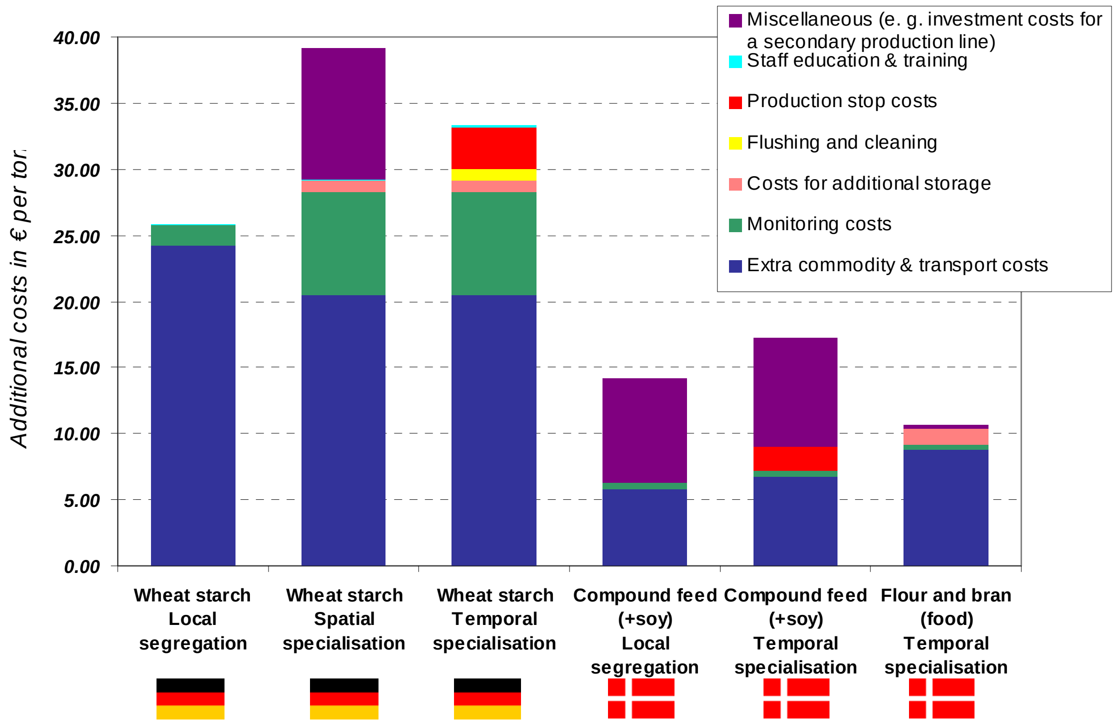
Processor

For the industry level (milling and processing), the total prevention costs due to co-existence and traceability are hardly to match as different products and differing production capacities prohibit a direct comparison of the observed value chains. Charged results refer to the produced unit (€ per ton), but the rate of yield when producing starch out of wheat is different compared to the production of flour, bran or compound feed out of wheat.

The supply chain of wheat starch in Germany provides a more premium-type product compared to the feed and flour production in Denmark. The yield of starch out of one ton of wheat is around 50 % while e.g. wheat is used in an almost unprocessed form in animal feed. The gradation of the total costs within the three co-existence and processing strategies is also shown in the results (figure 3). Having the possibility to segregate the non-GM and GM production in two sites (local segregation), this strategy induces the lowest costs, while the spatial specialization with investing in a second production line drives into the highest economic efforts (figure 3).

[1] Storage at farm side

Figure 3: Comparison of the German and Danish cost structure for producing non-GM wheat products at processing industry level



Source: Own calculations within the EU FP6 CoExtra project

3.2 Sugar supply chain

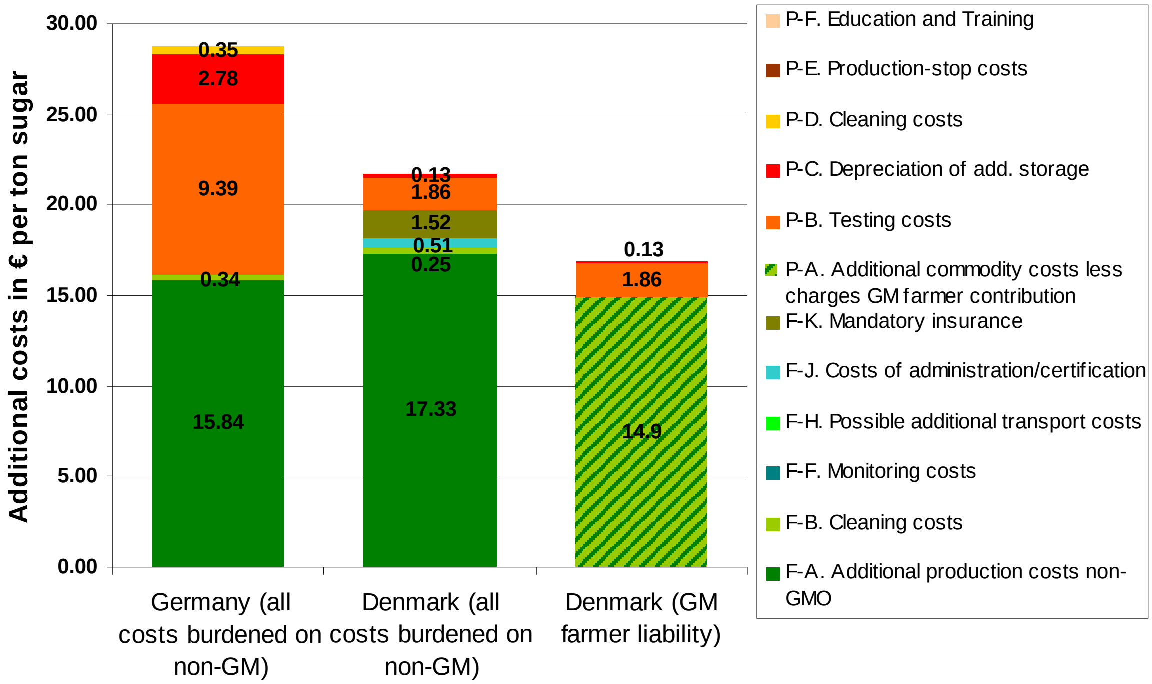
A comparison of the additional costs of co-existence and traceability for sugar beet processors in Germany and Denmark is interesting as in both countries, the sugar industry is mainly dominated by one or few multi-national companies with Dansico A/S in Denmark or Nordzucker AG, Südzucker AG and Pfeifer&Langen KG which are dominating the German sugar distribution (WVZ 2007, Danish Competition Authority 2007). For both countries a hypothetical 50 % GM adoption rate and an insignificant import of sugar beet is anticipated. A strict contract system between sugar companies and surrounding farmers who grow sugar beet exclude the elevator level in the value chain. In the following, the farming and the processing level are considered to give an overview concerning the different assumptions, considered cost types and impacts in the two countries (table 3).

Table 3: Set-ups of farm and processor levels in the sugar supply chain

Country	Germany	Denmark
Set up farm level (sugar beet)		
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	+ 17.5 %	+ 33 €
Yield	60 tons	57 tons
Average field size	9.3	6.2
Perceived benefits	Lower production costs Higher yield (5 %)	Cost reduction pesticides Cost reduction machinery
Selling price (2007)	32.90 € (2006-2007)	26.3 €
Set-ups sugar processor level		
Company	Anonymous	Danisco A/S
Annual amount of beet	1,100,000 tons	2,800,000 tons
Annual amount of sugar	150,000 tons	421,000 tons
Sugar content in beet	~ 15 %	~ 15 %
GM adoption rate	50 %	50 %
Preferred strategy	Temporal specialisation	Temporal specialisation

As the operating sugar companies in both countries hold several factories, the choice of strategies to ensure co-existence is more open than for one-site companies. In the country calculations for the sugar value chain, the temporal specialisation strategy emerged more economical than the local segregation strategy (due to lower transport costs of sugar beet). In order to get a direct comparability between the two countries, the sugar content of the beet was harmonised with around 15 %. Figure 6 shows the variable cost distribution over the two chain levels in Germany and Denmark as well as an additional analysis of the cost allocation when part of the co-existence costs are burdened on the GM farmer. The Danish legal framework allows that farmers who decide to grow GM crops are also liable for the costs that affect the implementation of co-existence measures. This is the case shown in the third column presented in figure 4.

Figure 4: Distribution of co-existence costs in German and Danish sugar industry



Source: Own calculations within the EU FP6 CoExtra project

Figure 4 points out that different cost types are decisive for the co-existence costs in the two countries. In the German case, the costs at processor level play a bigger role than in the Danish case. Derived from the statements of the interviewed German sugar producers the testing, cleaning and storage costs will explicitly increase if co-existence is realized in one factory. In the Danish study, the co-existence and segregation costs mainly occur at the production levels of the supply chain. The segregation of allocation of liabilities of admixture prevention strategies for GM or non-GM farmers significantly influences the total costs on the farming side.

3.3 Rapeseed oil supply chain

Due to the relatively homogenous character of the final product, the supply chains of edible rapeseed oil can also be directly compared between Germany and Denmark so that country-specific preconditions, farming and industry structures and the regulatory framework (as well as the accessible data) highly influence the co-existence cost structure.

Seed level

With regard to seed production of rapeseed, co-existence and segregation of GM and non-GM varieties are suitable in basic seed production if GM and non-GM plants are segregated in different sites. The co-existence costs arise from the prevention activities in order to ensure high purity of non-GM seeds while having the production of both GM and non-GM varieties. Costs in seed breeding will arise throughout additional personnel costs and investment costs in new production facilities. Co-existence and segregation of GM and non-GM varieties in seed multiplication would only be feasible under high efforts like sufficient isolation distances e.g. in isolated areas, where isolation distances strongly depend on crops. Rapeseed reproduction will be difficult due to pollen cross-contamination of rapeseed and other sources of unintended GMO-admixture. In this context, feasibility is a question of thresholds, but a threshold of 0.1 % will not be possible. Alternatively, seed breeding companies might opt for a GM-free region in order to avoid the risk of GM contamination in rapeseed seed production (Menrad and Reitmeier 2006). The additional co-existence costs constitute up to 10 - 20 % of the existing costs for cultivating rapeseed certified seeds. These extra costs are added to the seed price per unit and handed on (as technology fee) to the farming level (Kasamba and Copeland 2007, Brookes 2002).

Farming

Due to differing conditions in Germany and Denmark, table 4 defines the preconditions for calculating the co-existence and traceability costs on farm level. According to the assumed production benefits of the cultivated GM variety, it is necessary to consider the additional production costs that have to be settled on non-GM rapeseed production. Thus, the difference of gross margin between GM and non-GM crop is attributed as additional price premium of non-GM and therefore influences the total commodity costs in the case of co-existence.

The costs for cleaning and flushing efforts in sowing, cropping and harvesting machinery depends on the type of machinery management (machine sharing or own machinery), the proportion of machine utilisation on GM fields and the use of shared capacity on GM and non-GM rapeseed areas.

Clearer differences can be seen in the choice and implementation of certain isolation strategies between the analysed countries. While a discard width is assumed on the non-GM field for the German farmer, no relevant isolation measures were considered for the Danish farmers according to national co-existence regulation. These differing legal preconditions are one major reason for the difference of corresponding farm-related co-existence costs of 40 € per ha in Germany compared to 75 € per ha in Denmark.

Table 4: Preconditions for cost calculation of co-existence and traceability of rapeseed oil supply chain

Country	Germany	Denmark
General preconditions	▪ Edible rapeseed oil for human consumption ▪ 50% GM adoption rate ▪ GM threshold 0.3 – 0.5% at seed level ▪ Prior domestic production ▪ Products for human consumption and food industry ▪ Processing strategy: **temporal specialization**	
Farm level	▪ 12 ha field size ▪ Yield 3.5 tons/ha ▪ No direct production benefits are assumed ▪ Applied isolation measures: non-GM field discard width of 100m, rye as alternative crop ▪ Allowance of indicative insurance and on-field monitoring ▪ Liability attribution: non-GM farmer (full)	▪ 4 x 5ha field sizes ▪ Yield 3.6 tons/ha ▪ Production benefit: glyphosate resistant GM rapeseed (reduction in herbicide)[1)] ▪ No relevant isolation measures according to Danish co-existence regulation ▪ Mandatory costs on GM farmer, on-field monitoring ▪ Liability attribution: non-GM farmer (mixed)[2)]
Total additional costs	▪ **74.4 € per ha**	▪ **40.1 € per ha**
Elevator level	▪ Large elevator (400,000 tons per year) ▪ Strategy: **local segregation** ▪ Additional transport costs due to longer distances ▪ Restriction to input testing ▪ Additional transport costs (cleaning)	▪ Most rapeseed in DK goes directly from the farm to the crusher and very little through the "elevating system", therefore no co-existence costs for elevators are assumed.
Total additional costs	▪ **17.29 € per ton** ▪ **4.6 % of turnover**	
Oil mills	▪ 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
Total additional costs	▪ **74.10 € per ton** ▪ **8.3 % of turnover**	▪ **83.16 € per ton** ▪ **8.3 % of turnover**

[1)] Roundup Ready rapeseed
[2)] Liability attribution: costs that occur in case of co-existence on the GM farmer (mandatory payments, GM certification etc.) are added (mixed) on the non-GM prevention measure costs to detect full cost impact

Source: Own calculations within the EU FP6 CoExtra project

Elevator

As in Denmark, most of the produced rapeseed is currently delivered directly from the fields to the oil mills and processors, the “elevator system” is eliminated from the further cost calculations for Denmark. Important criteria for the total additional costs at the German elevator level are the chosen elevating strategy and the segregation and traceability management of the company. Altogether, the applied co-existence measures result in costs of 17.3 € per ton or 4.6% of the product turnover for the German elevator (table 4).

Crusher (oil mills)

In both country studies, interviews were carried out with major oil milling companies which showed that temporal specialisation, i.e. switching from GM to non-GM production at only one production site seems to be the most appropriate strategy. (table 4). The commodity price premium of non-GM rapeseed, including all previous costs of co-existence and segregation results in the biggest share of additional costs for oil mills. However, there are different percentages of price premia and thus commodity costs assumed in the two countries. One reason of this discrepancy is surely the different raw material prices assumed in the analysed countries. The Danish calculations act on the assumptions that no elevating system is interposed. The function of purifying, commissioning and storing of rapeseed is done on the farm level embracing smaller batches. The omission of the elevator stage reveals 11 % higher commodity costs in the Danish cost calculations compared to a price premium of 4.6 % in the German case (table 4).

The remaining cost types mainly refer to the individual management of temporal specialization estimated by the interviewed companies. Especially the monitoring strategy again depends strongly on the determined testing system, supply's mode of transport, intensity and applied test methods. As no reference system exists in the two countries in the way of established and regularized monitoring systems in the case of GM/non-GM co-existence in rapeseed milling, frequencies and single testing costs are transferred from interviewees' estimations to quantify the economic impact of such systems on the processing level of the rapeseed oil chain. At the end of the analysed supply chains, the aggregated additional costs of around 74 € per ton in Germany and 83 € per ton in Denmark are similar for both countries if the costs are set into relation to the product turnover resulting in additional co-existence costs of 8.3 % of the product turnover (table 4).

4. Discussion and conclusions

According to the results of the analysed food supply chains, significant additional costs are expected by organizing co-existence between genetically modified and non-GM products in the value chain from production of farm crops up to the processing level of the single supply chains and by maintaining mandatory (or voluntary) thresholds and regulations. Depending on factors like crop requirements, farming, storage and elevating systems, processing strategies, monitoring managements, etc., the total additional costs of co-existence and product segregation systems can raise up to 12 % of the total product turnover at the gates of rapeseed oil mills, the sugar or starch industry. However, as in most value chains the question of co-existence is a theoretical one at the moment, the implementation and permanent running of segregation and traceability systems in the food industry can decrease the additional costs due to savings e.g. in the testing requirements of raw materials or routine procedures during the documentation process. The dimension of implementation efforts also strongly depends on national regulatory specifications as well as the existing capacities, equipments and conditions of the actors along the supply chains.

Basically, the cost structures and the results of the cost calculations between the two countries do not only differ because of national differences in implementing the existing co-existence regulations of the EU, divergent farming or industry structure, but also due to the information given in the conducted interviews and available data e.g. concerning costs of specific activities. An example for differing cost structures is the impact of co-existence measures in farming in the two countries. Several possible strategies of maintaining isolation distances between GM and non-GM fields can be applied depending on the regional field distribution and national regulation of liability. Thus, the individual combination of cost types and the particular origin of data have to be respected when comparing the country-specific results of the cost calculation.

On the basis of the case studies conducted, we can conclude that every actor and supply chain level will be economically affected under a co-existence scenario. As the additional commodity costs is the most relevant cost category at the elevator and processor level, the farm level borne co-existence costs are of particular importance. In this respect, the most determining factors are the isolation measures to ensure the 0.9 % threshold of GM admixture, the threshold determined for “GM-free” seeds, the farm structure and the regional penetration level of GM commodities etc., which all finally influence the price premium between GM and non-GM commodities at farm level.

In this research it could be shown that the costs of GMO-related co-existence and traceability systems can only be calculated on a case-by-case basis for a specific value chain and are influenced by multiple dynamically changing factors. In order to handle this situation, regulators are challenged by the fact that static co-existence and traceability rules might lead to inefficient solutions in economic terms. Therefore, regulators should only define the framework of GMO-related co-existence in the agro-food chain. Based on this defined framework, a flexible handling of co-existence rules is strongly recommended in order to allow actors in a specific value chain to implement the most cost-effective co-existence strategy and measures.

The project teams faced the challenge that in most value chains the question of GMO-related co-existence is a theoretical one in the EU at the moment. This resulted in partly significant uncertainties concerning relevant data and applied strategies during the interviews so that the development of the costs of co-existence systems in future cannot be calculated on a reliable data base. However, the experiences gained when implementing co-existence systems in other areas of the food supply chain (e. g. for organic food, or in the field of fresh fruits and vegetables) indicate that the permanent running of co-existence and segregation systems in the food industry can decrease the additional costs due to savings e.g. in the testing requirements of raw materials or routine procedures during the documentation process. This might result in cost savings in case GMO-related co-existence and traceability systems are established in the EU in future.

Conversely, it can be expected for the coming years that additional branches of the food industry in the EU will be faced with the challenge of an increasing risk of GMO-admixture mainly due to the globally growing cultivation area of GM crops. This will lead to additional and increasing costs to further realise the “prevention-strategy” which is currently adopted by most companies of the food industry in the EU even if very few (or no) GM plants are cultivated in the EU.

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