EU policy on GMOs

A quick scan of the economic consequences

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LEI
Gé Backus
Petra Berkhout
Derek Eaton
Ton de Kleijn
Eveline van Mil
Pim Roza
Wilhelm Uffelmann

PRI
Linus Franke
Bert Lotz

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Backus, G.B.C., P. Berkhout, D.J.F. Eaton, L. Franke, A.J. de Kleijn, B. Lotz,
E.M. van Mil, P. Roza and W. Uffelmann
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The cultivation of genetically modified (GM) crops has seen a rapid growth since 1996, especially in North and South America. In the European Union (EU) the cultivation of GM crops is still rather limited. In contrast, the use of GM crops in the EU is rapidly increasing.

Over the last years there have been increasing difficulties with the EU import of (GM) food and feedstuffs from major exporting countries. This is caused by the asynchronous EU approval of GM crops, coupled with the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU. This policy of the EU has already led to difficulties with the import of raw materials from exporting countries where more GMOs have already been approved or are under development. This report argues that it is likely that in the near future problems will become more urgent. This could negatively affect the EU supply of raw materials and economic position of the European agricultural and food sector.

Orders
31.70.3358330
publicatie.lei@wur.nl

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Preface

The cultivation of genetically modified (GM) crops has seen a rapid growth since 1996, especially in North and South America. In the European Union (EU) the cultivation of GM crops is still rather limited. This is among other things caused by the lengthy procedure in the EU for the approval of new genetically modified organisms (GMOs). In contrast, the use of GM crops in the EU is rapidly increasing, as the EU livestock industry is highly dependent on the import of soybean products and to a lesser extent maize products. These products are mainly sourced in countries where the cultivation of GM crops is widespread. The import of GM products by the European food industry is less important, due to the avoidance policy of the EU food industry of GMOs.

Over the last years there have been difficulties with the import of (GM) food and feedstuffs from major exporting countries. This is caused by the asynchronous EU approval of GM crops, coupled with the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU, another key element of the EU policy regarding GMOs. It is likely that in the near future more trade problems will occur with the EU import of raw materials from exporting countries where more GMOs have already been approved or are under development. This could negatively affect the economic position of the European agricultural and food sector.

The Dutch ministry of Agriculture, Nature and Food quality has asked LEI and PRI to assess these possible economic impacts. As time was limited, the assessment has been carried out through a quick scan.

The authors wish to thank B. van den Assum, R. Dirkzwager, M. Mooren and Besseling of the Dutch ministry of Agriculture, Nature and Food Quality for their useful comments during the inception of the report. The information given by a number of persons in the food and feed industry, through interviews and documents, has been most valuable as well. Without the assistance of these key persons, the report would have been less well documented.

Prof. Dr R.B.M. Huirne
Director General LEI Wageningen UR

Summary

The cultivation of genetically modified (GM) crops has seen a rapid growth since 1996, especially in North and South America. In the European Union (EU) the cultivation of GM crops is still rather limited. This is among other things caused by the lengthy procedure in the EU for the approval of new genetically modified organisms (GMOs). On average, the procedure can take up twice as long in the EU compared to other countries.

In contrast, the use of GM crops in the EU is rapidly increasing, as the EU livestock industry is highly dependent on the import of soybean products and to a lesser extent maize products. These products are mainly sourced in countries where the cultivation of GM crops is widespread. The import of GM products by the European food industry is less important, due to the avoidance policy of the EU food industry of GMOs.

The asynchronous EU approval of GM crops, coupled with the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU has led to difficulties with the EU import of (GM) food and feedstuffs from major exporting countries. Unapproved GMOs - that is to say unapproved for cultivation or use in food or feed in the EU - that may have been approved for commercialisation in other countries, are not allowed in the EU and should be taken from the market, even when these unapproved GMOs are unintentionally present at a very low level. Impurities or contaminations in traded commodities are however difficult to avoid, and it is common practice in food safety legislation that minute presence is allowed of certain unwanted materials (e.g. dirt, weed, mycotoxins).

With the more widespread cultivation of GMOs that are approved in the exporting countries but not, or not yet, in the EU, potential trade disruptions could become more severe, more frequent, and affect more products. Imports may be interrupted, slowed down considerably or come to a halt altogether, as traders may become unwilling to assume the risk of having traces of EU non-approved GMOs detected in their shipments. A number of these incidents have already taken place in the past.

As a consequence, European livestock producers face the risk of being cut off from especially high-quality, protein rich feedstuffs that are essential to feed their animals. EU demand for protein rich feedstuffs (in particular soybeans and soybean meal) is substantially higher than can ever be produced within the EU. The EU imports about 77% of its protein needs; the EU's degree of self-

sufficiency in protein rich feedstuffs is around 23%. An interruption of soybean/meals may significantly decline EU livestock production, leading to substantial disruptions to livestock producers, related suppliers and processors. Without a sufficient supply of feed ingredients which forces livestock operators to use less satisfactory and more costly alternatives, the competitiveness of EU livestock production will weaken further and European livestock operators will loose market share in domestic and world markets to foreign competitors. It is however difficult to assess whether large trade disruptions will already occur in the next coming season. This would only take place if all main exporters to the EU would switch to new varieties not yet approved in the EU at the same time. This is hardly likely.

A loss in competitiveness of the EU livestock sector is likely to have important implications for agricultural incomes and employment, with considerable knock-on effects in the upstream and downstream industries, and significant increases in meat prices for consumers. Eventually, the EU will need to import its meat from countries where animals are reared on the same feed materials that European producers are not allowed to use.

For the food industry the problems lie in the sourcing of conventional raw materials. Although it may be expected that in the medium term availability of conventional raw material is not likely to pose a problem, the zero tolerance policy could very well be a problem. Even despite identity preservation systems it is very difficult to prevent traces of GMOs in shipments. Combined with traceability systems that are improving every year, it is not difficult to imagine the problems the food industry will have sourcing raw material. Another effect will be that conventional raw material will also have to be bought at a considerable cost, as identity preservation systems are quite costly. For a number of food products, with high incorporation rates of the raw material, this could affect the consumer price as well. The EU's approach of protecting its inhabitants of GMOs not yet approved in the EU by a zero tolerance threshold is thus projected to come at a significant cost.

The last chapter provides an overview how GMOs can contribute to the sustainability of farming in terms of People, Planet and Profit. The current and expected contributions of GMOs to reduce the environmental burden of farming (Planet) are summarised. The cultivation of GM crops can contribute to the Planet dimension of sustainable farming by: reducing the need for crop protection agents; reducing the demand for agricultural land; stimulating agricultural practices that are beneficial to the environment; and reducing environmental pollution during crop processing after harvest. The People dimension of sustainable farming pertains to fair and beneficial farming practices toward labour and the farming community and the region in which farming is conducted.

The findings presented are dependent on underlying assumptions and on the quality of the available information. The need to simplify the analysis has resulted in three important limitations. First, in evaluating the impact of the current EU policy on GMOs, the time constraint did not enable full analysis of the impact on the food industry. We did not assess the consequences of the possible redirection of investments by major food companies to non-EU countries on innovation. Second, the possible consequences of shifting consumption patterns from poultry to beef meat were not analysed. Finally, valuation of the benefits associated with conventional production and consumption is outside the scope of this study.

1 Introduction

1.1 Background

Over the last twelve years cultivation of genetically modified crops has seen a rapid development world-wide. Especially in North and South America the area of genetically modified (GM) crops has increased at an unprecedented pace. For a crop like soybeans, the area planted in 2007 with GM crops as a share of the total area planted is over 90% in the USA and Argentina and around 60% in Brazil. In the European Union (EU) the cultivation of GM crops is still rather limited. The lagging cultivation of genetically modified crops in the EU, as compared to other countries, follows among other things - like the presumed consumer resistance against genetically modified organisms (GMOs) - from the protracted procedure the EU applies for the approval of new GMOs. On average, the procedure can take up twice as long in the EU, compared to other countries. This lengthy procedure is mainly caused by very differing views within the EU about the need to allow genetically modified crops.

In contrast, the use of genetically modified crops in the EU is rapidly increasing, as the EU livestock industry is highly dependent on the import of soybean products and to a lesser extent maize products. These products are mainly sourced in countries where the cultivation of GM crops is widespread. The import of genetically modified products by the European food industry is less important, due to the avoidance policy of the EU food industry of GMOs.

Over the last years there have been difficulties with the import of (GM) food and feedstuffs from major exporting countries. This is mainly caused by one of the key elements in the EU legislation regarding GMOs, the zero tolerance policy regarding unapproved GMOs.[1] Unapproved GMOs - that is to say unapproved for cultivation or use in food or feed in the EU - that may have been approved for commercialisation in other countries, are not allowed in the EU and should be taken from the market, even when these unapproved GMOs are unintentionally present at a very low level. Impurities or contaminations in traded commodities are however difficult to avoid, and it is common practice in food safety legislation that minute presence is allowed of certain unwanted materials (e.g. dirt, weed, mycotoxins). The general rule is the more hazardous the

[1] Appendix I gives a concise overview of the key elements of the EU legislation regarding GMOs.

contamination, the lower the level of the accepted presence. The zero tolerance policy for unapproved GMOs is the exception to this rule.

Since 2004 a number of cases is known whereby products containing unauthorised GMOs have entered the EU (EC, 2006a). The cases mentioned in the report of the European Commission concerned papaya, rice and maize. The Annual Report 2007 on the Rapid Alert System for Food and Feed mentions 74 notifications in total for GMOs and/or novel food. The number of notifications on unauthorised genetically modified feed rose from 9 in 2006, to 12 in 2007, of which 6 on rice and 6 on maize DAS 59122 (EC, 2008). Of the total of twelve, 5 related to pet food. The possibility of undiscovered occurrences with impurities present at low level cannot be excluded.

It is expected that in the future the number of cases where traces of GMOs not (yet) approved by the EU are found in EU imports will rise, in view of the rapid commercialisation of new GMOs. This 'contamination' could occur during harvesting, transport or processing and could either occur with import of EU approved GMOs or with conventional products, therefore potentially disrupting both the supply of the food and feed industry. The majority of 'contaminations' could then concern GMOs that have been approved in other countries but not (yet) in the EU. It is expected that this situation might soon rise with a new soya bean variety, the Roundup Ready 2 Yield, which has already been approved for commercialisation in several countries, including the US and its major export markets (ASA, 2008a). In the longer term, the same goes for another soybean event that is in the pipeline, Optimum GAT/glyphosate-ALS[1]. The presence of traces of GMOs not (yet) approved by the EU will lead to the refusal of shipments. In the longer run, it is likely that the sourcing of EU approved GM crops or conventional crops could become a problem. This might negatively effect the economic position of the European agricultural and food sector.

The EU policy regarding GM crops has raised concerns at several levels within the EU, Member States as well as the European Commission and within the food and feed industry. According to the CIAA, the Confederation of the food and drink industries of the EU,

> 'Notwithstanding efforts undertaken by exporters and importers to channel conventional and GM material, no measures can adequately prevent widely commercialised events from entering the European food chain. Traces of EU-unauthorised GM material will continue to be discovered in the European

[1] The Liberty Link soy variety has recently been approved for import and use in food and feed by the EU.

> food chain leading to the removal of both raw materials and related processed products from the supply chain' (CIAA, 2007a).

FEFAC, the European Feed Manufacturers Federation, in a position paper on the issue of GM products calculates that the EU imports about 77% of its protein needs, mainly soybean and maize products, to feed its livestock.

> 'Imported substitutes for these feed ingredients are only available in very limited quantities and domestic grain production is insufficient to satisfy the required volumes and nutritional requirements' (FEFAC, 2007:2).

1.2 Objectives

This quick scan aims to assess the possible economic impacts, now and in the future, of the asynchronous nature of EU procedures to approve GMOs, combined with the zero tolerance policy for the presence of GMOs not yet approved in the EU. The analysis is limited to soybean and maize, as these products are the most important in terms of use within the EU.

To this purpose, the report shortly outlines the current production and trade in the most important genetically modified crops (chapter 2). Chapter 3 describes developments in different parts of the food and feed chain, either to give insight in the impact of the current EU policy regarding GMOs or to shed light on the problems the EU might encounter if the current policy is sustained. Chapter 4 explores the 'GMO-free' scenario, assuming the food and feed sector wish to avoid all use of GM raw materials. Finally, chapter 5 describes the potential contribution of GMOs to sustainable agriculture and food quality. The report concludes with discussion and conclusions.

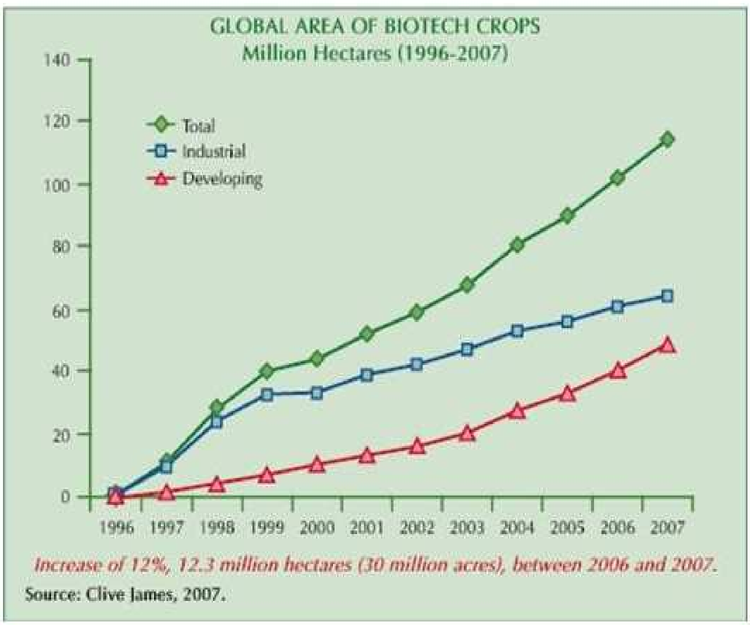
The report has been compiled based largely on desk research and analysis, including literature review. In addition, a number of interviews have been held with key persons in the feed industry and organisations connected to both the food and feed industry.

2 Facts and figures about genetically modified crops

2.1 World-wide development of biotech crops

The year 1996 is generally seen as the starting year for the commercial growth of genetically modified crops (GM crops), although cultivation already took place in 1994, when the first genetically modified tomatoes were planted (Brookes and Barfoot, 2008). Figure 2.1 shows the rapid increase in the global area of biotech crops these past twelve years.

Figure 2.1 **Global area of GM crops, 1996-2007**



Since 1996 the area of GM crops has grown to 114.3mn ha (James, 2007). It is widely believed that the area of GM crops will continue to grow. The substantial adoption rate of planting GM crops in main developing economies like Brazil, Argentina, India and China is considered to have an increasing collective impact on the acceptance and future adoption of biotech crops worldwide. The ISAAA states that the number of GM crop countries, as well as crops, traits and hectares, are projected to double between 2006 and 2015, the so-called 'second decade of GMO commercialisation' (James, 2007).

The most important GM crops grown are soybean, maize, cotton and rapeseed. In 2007 GM soybean cultivation accounted for 51% of the global GM crop area. GM maize came second representing 31% of the global GM crop area. GM cotton occupied 13% and canola (a GM rapeseed variety) 5%.

The share of GM crops as compared to conventional crops is also increasing. By 2007, GM soy as a percentage of the global area of soy amounted to 64%; this percentage for GM maize was 24, for GM cotton 43, and for rapeseed 20 (see Table 2.1). Because new GMO events continue to be introduced around the world, these new products make up greater proportions of the agricultural commodities available for import.

Table 2.1 Global cultivation areas in millions of hectares, 2007

	Area	Area GM	Proportion GM
Soy	91	58.6	64%
Maize	148	35.2	24%
Cotton	35	15	43%
Rapeseed	27	5.5	20%

Source: GMO Compass, Global Cultivation Areas 2007; based on ISAAA data.

Although cultivation of GM crops started in the industrial countries, growth has picked up in developing countries as well. In 2007, 23 countries planted biotech crops, of which 11 industrial countries and 12 developing countries. About 43% of the global GM crop area (equivalent to 49.4mn ha) was grown in developing countries. Growth between 2006-2007 was higher in developing economies (8.5mn ha, or 21% increase) than in industrial countries (3.8mn ha, equivalent to 6% growth).

2.2 Developments by country

The USA has the largest area of biotech crops, almost 58mn ha, followed by Argentina and Brazil. Table 2.2 shows the countries with the largest cultivation areas, growing more than 2mn ha of GM crops.

Table 2.2	**Area (million hectares) GM crops in main producing countries, 2002-2007**					
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
USA	39.0	42.8	47.6	49.8	54.6	57.7
Argentina	13.5	13.9	16.2	17.1	18.0	19.1
Brazil	1.5	3.0	5.0	9.4	11.5	15.0
Canada	3.5	4.4	5.4	5.8	6.1	7.0
India	0.0	0.1	0.5	1.3	3.8	6.2
China	2.1	2.8	3.7	3.3	3.5	3.8
Paraguay						2.6
Source: European Commission (2006b;) James (2007).						

The relative importance of GM crops for the four countries with the largest GM cultivation areas is reflected in Table 2.3, showing the shares of GMO plantings as a percentage of total planted acreage.

Table 2.3	**Plantings of GMOs in major countries as % of total acreage**					
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
USA						
- Soybeans	74	80	85	87	90	92
- Corn	32	40	45	52	60	60
- Rapeseed	..	70	70	75	75	75
Canada						
- Rapeseed	55	60	65	80	80	..
- Soybeans	60	65	80	85	90	90
Argentina						
- Soybeans	95	99	98	98	98	99.5
- Corn	30	35	40	60	65	65
Brazil						
- Soybeans	35	35	40	40	40-45	60
Source: Fefac (2007:5). Based on USDA; IAAS; Agriculture Canada. ASA (2008b).						

Cultivation in the European Union of GM crops is limited. Maize is the only GM crop that is grown commercially in the EU and Spain the only country were more than 50,000ha of GM maize is cultivated. In 2007 France[1], the Czech Republic, Portugal, Germany, Slovakia, Romania and Poland also grow GM maize, but less than 50,000ha.

[1] The cultivation of GM maize was banned by the French government at the end of 2007.

2.3 Use of soybeans and maize by the EU industry

Soybeans

The EU imports large quantities of soybean (products) and is not self sufficient for soybean (products); appendix 2 gives the supply balance for soybeans, oil and meal. Soybeans are used in both the feed and food industry. Most soybeans are crushed in oil mills, the oil and its derivatives (e.g. lecithin) are used in a wide range of products for human consumption. The protein rich soy meal is mainly used in the feed industry. A small amount of soybeans is not crushed but used for protein additives (made from de-oiled soy flakes) and for traditional soy products like tofu, or the flour is used for products like bread and instant milk drinks.

Soybeans are for the larger part genetically modified, according to Brookes (2008) about 10% of the current proportion of total soybean and derivative use in the EU is conventional soybean. Use of conventional soy is almost entirely concentrated in the human food sector.

The import of soybeans and soybean meal has steadily grown since the nineties. The last couple of years, import seems to stabilise around 34-35mn tonnes (in soybean meal equivalents). This is almost three times the amount of the domestic production of soybean meal from imported seed (around 12mn tonnes, see appendix 2). Argentina and Brazil are the main exporters of soybeans to the EU, the share of the USA in the exports to the EU has more than halved this last decade. The export of the USA to the EU mainly consists of GM soybeans (the GM soy variety currently grown most in the USA is also allowed in the EU), while the EU food industry demands conventional soy. Presently, Brazil is the only large exporter of conventional soy considered relevant for the EU.

Maize products

Maize products can be subdivided into maize grains, corn gluten feed (CGF) and distillers dried grain (DDG). Maize grains are used as feed and for a number of food products (f.i. bread and pastry). CGF and DDG are by-products of the processing of maize into ethanol and starch; they serve as feed. Starch is used in a range of foods and food additives.

The EU is by and large self-sufficient for maize, appendix 2 gives the maize supply balance for the EU. Imports of maize range between 4 to 8% of the production in the EU-27, with the exception of 2006, depending on the production within the EU. The import of maize by-products is slightly higher. According to figures of FEFAC (2007) the share of the import of CGF and DDG in total import of feedstuffs is nearly 9%. The dependency of the EU on the import of maize products is however much less compared to soybean products.

Almost all maize by-products imported by the EU are genetically modified, as the USA is the main supplier of maize by-products to the EU. Traditionally, the EU has imported 4 to 6mn tonnes of US maize by-products per year. With regard to CGF and DDG, the EU had been importing 2.6mn tonnes of CGF and 700,000 tonnes of DDG in the 2005/2006 marketing year. This declined to 1mn tonnes of CGF and 290,000 tonnes of DDG in 2006/2007, and has been expected to fall further in 2007/2008 to around 300,000 tonnes of CGF and less than 100,000 tonnes of DDG (Toepfer International, ibid). This is entirely due to the use of the Herculex Root Worm Corn (DAS 59122-7) maize variety which was then not yet authorised for use in the EU. In April and May 2007 three vessels with CGF (and DDG) tested positive for DAS-59122-7 in the port of Rotterdam. The cargo of the last two ships has not been imported, but has been stored under bond in Rotterdam. These shipments were put on hold until the maize event was authorised in the EU (in September 2007). The first vessel carried 6,516 tonnes of CGF, of which 2,542 tonnes were still in storage with feed companies and had not been processed. The rest of the shipment, 3,974 tonnes, had already been processed and delivered to about 800 farmers. The former has been returned to the port of Rotterdam, but returning or destroying the latter would have incurred costs equal to €2,500 per tonne (€9.9mn in total), since the CGF had already been mixed.[1] But the majority of the feed had already been used and therefore the real costs would amount to €40,000 (for 160 tonnes of feed). In the end the Dutch Ministry of Agriculture, Nature and Food Quality decided not to return these 160 tonnes of feed, largely based on the fact that the European Food Safety Authority had given a positive opinion on the DAS-59122-7 event (information ministry of LNV).

In addition, the US 2007 maize crop could not be imported into the EU as a result of the planting of Agrisure RW (MIR 604, Syngenta) and Yieldguard VT Rootworm (MON88017, Monsanto) on approximately 1.5-2% of the planting area, as these GM maize varieties are also not yet approved by the EU.

[1] Based on a mixing percentage of 10% on average, the recall of 1 tonne of corn gluten feed (with an average value of €150) means a destruction of 10 tonnes of feed with a value of €2,500 (€250 per tonne).

Rapeseed/colza

A third important crop for the European food and feed industry is rapeseed. Global production of rapeseed in 2007 was estimated at 51mn ton. It is the second largest oilseed crop, after soybeans, although global production is less than a quarter of the global soybean production (Oilcrops outlook/USDA/ERS). The main producing and exporting countries are Canada, Australia, Ukraine and Russia. The EU is almost self-sufficient, appendix 2 gives the supply balance for rapeseed. In the short term no supply problems are expected. In the longer term this might change as rapeseed is used for the production of biofuels as well.

3 Impact of the current EU policy on GMOs

3.1 Introduction

This chapter describes developments in the different parts of the food and feed chain, from the seed companies down to the final consumers. The aim is - where relevant - to give insight in the impact of the asynchronous EU approval of GM crops, coupled with the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU. This concerns for instance importers and exporters. For other parts of the chain, for instance seed companies and growers, the description serves to shed light on the problems the EU might encounter if the current policy regarding GMOs is sustained.

3.2 Seed companies

This paragraph gives an overview of the expectations concerning new GM varieties of soybean and maize in the R&D pipeline of major developers in North and South America[1] (developments in this area in the EU are limited, see box page 21). For both soybean and maize, a number of new varieties are in the 'prelaunch' phase or have even completed regulatory approval in the US. Their release can in principle be expected on the market in 2009 or 2010. Some of these varieties are 'first-generation', in the sense that the engineered traits offer agronomic benefits. In addition though there are also various 'second generation' varieties offering benefits in terms of product quality (for users such as food/feed processors, livestock farmers, or consumers).

Available information on these varieties, in particular their regulator status, is summarised below, first for soybeans and then for maize. An open question remains the possible effect of the regulatory approval process outside the US in influencing the decision by seed companies to delay the commercial launch within the US, due to concerns of farmers and exporters about trade disruption.

[1] This information does not include recent 'older' GM varieties approved in the US and possibly elsewhere but that have still not received final approval in the EU.

Soybean

Table 3.1 summarises soybean varieties in the R&D pipeline of major developers. The table shows only those products in the last two phases of development, advanced development and prelaunch, in order to concentrate on those nearing commercial launch. It is important to realise that not necessarily all of these products will be commercialised in the end. Some may not pass extended field testing or regulatory approval for example.

Note that many of those in the prelaunch phase have been submitted for regulatory approval and appear below. Those varieties may be on the market in either 2009 or 2010. Where possible, the year of expected launch indicated by the company is provided.

Table 3.1 Soybean R&D pipeline major developers

Phase 3 a) Advanced development	Phase 4 Prelaunch
Vistive III (Monsanto)	Roundup Ready 2 (Monsanto) 2009
Omega-3 (Monsanto)	Liberty Link (Bayer) 2009
High-oil (Monsanto)	Optimum GAT/Glyphosate-ALS (Pioneer) 2010
Dicamba-tolerant (Monsanto)	High Oleic Soybeans (Pioneer) 2009
Insect-protected + RR2 Yield (Monsanto)	
Low Lin b) (Syngenta) 2009	

a) For some products in the advanced development phase, it is not clear from available information whether these involve genetic modification; b) Mentioned by American Soybean Association but not confirmed on Syngenta websites.
Source: company reports and websites, August 2008, not exhaustive.

Roundup Ready2 soybean has been approved in the US, as well as Australia, Canada, China and Japan. According to the American Soybean Association, seed is being produced during the 2008 season in anticipation of planting for production in 2009.

Bayer CropScience plans to have LibertyLink soybean (herbicide tolerant) available in 2009 in the US (www.bayercropscienceus.com/press/index.html). Note the LibertyLink event has existed for a number of years and been commercially incorporated in other crops, including maize.

Pioneer Hi-Bred has developed an herbicide tolerant soybean, Optimum GAT/Glyphosate-ALS, which is expected to be planted commercially in the US in 2010. This event is currently under consideration by EFSA (application acknowledged as valid 28 September 2007).

Pioneer has also developed a high-oleic soybean with a lower trans-fat content with expected commercial planting in the US in 2009. This is one of first second-generation varieties offering benefits in terms of improved quality (in contrast to agronomic benefits). This event is currently under consideration by EFSA (application acknowledged as valid 22 October 2007).

Appendix 3, Table A3.1, gives an overview of recently approved soybean events or approaching commercialisation for several countries.

Negative effect of EU GMO policy on innovative climate?

The biotechnology industry in Europe has repeatedly warned about the negative effects of the climate in Europe for decisions to undertake innovation. This refers though to various aspects, including specific political or consumer resistance, labelling and traceability requirements as well as the GM approval policy. Indeed much of the difficulty in undertaking GM crop research in Europe that leads to field trials is probably the risk of destruction by militant groups strongly opposed to the technology (see, for example, Economist, 2002).

The decision by Syngenta, described once by the Economist as 'Monsanto's European rival'[1] in 2004 to move much of its plant biotechnology research facilities from the UK to North Carolina's Research Triangle was perhaps the largest and most publicised example of a shift of R&D activities from Europe to the US (see for example Forbes 2005). This move however predates the current approval policy.

Nonetheless, the Competitiveness in Biotechnology Advisory Group with Industry and Academia (CBAG) states in its 2006 report to the European Commission, 'Still of great concern is the continued politicisation by certain EU Member States concerning decision making for approval of biotechnology research and development such as crop field trials and commercialisation approvals. It stigmatises the whole technology and acts as a severe disincentive to innovation and investment in the area. Moreover it is contrary to the declared objective of the Lisbon Strategy. It is time to implement the comprehensive new EU regulatory framework on GMOs and to move ahead with pending authorisations also for seeding and planting.' It is of course difficult to find specific examples of affected innovation or investment decisions. This does not mean that the effect is minimal, simply that efforts have not been made to assess it systematically.

Maize

Table 3.2 summarises maize varieties in the R&D pipeline of major developers.

[1] *The Economist* (2005), 'Trade trouble ahead', 13 January.

Table 3.2	Maize R&D pipeline major developers
Phase 3 Advanced development	**Phase 4 Prelaunch**
Drought-tolerant (Monsanto/BASF) SmartStax (Monsanto)	YieldGard VT PRO (Monsanto) 2009 Extrax + Mavera (Monsanto) Optimum GAT (Pioneer) 2010 VIP Broad lep (Syngenta) 2009
Source: company reports and websites, August 2008.	

Pending regulatory approval, Pioneer expects Optimum GAT corn (maize) to be commercially launched in the US in 2010. Monsanto has approval for YieldGard VT Triple Pro in the US and approval in a number of other countries. The company states that approval for important import markets are still underway and that it expects a commercial launch in the US in 2009. It is not clear whether the EU is one of these important markets, but an application has been submitted to EFSA.[1]

For the benefit of its membership, the US National Corn Growers Association maintains on its website a list of maize varieties available for planting together with information on their regulatory status in Japan and the EU.[2] For the 2008 planting season, this source listed 24 approved (for food and feed) genetically modified hybrid varieties that were commercially available in both the US and the EU. Table A3.2 in Appendix 3 presents an overview of recently approved maize events or approaching commercialisation for several countries.

Finally, the Syngenta website (technology pipeline: www.syngenta.com/en-/about_syngenta/research_pipeline.html) discusses launch in 2008 of a Triple Stack GT/RW/ECB (Glyphosate tolerance and resistance to rootworm and European corn borer) but this event has not yet been located in specific products (eg. from Garst Seeds), in GM databases, nor in press releases.

3.3 Growers

In 2007, a total of 12mn farmers planted GM crops - up from 10.3mn in 2006- of which 11mn (or 90%) can be typified as small and resource-poor farmers from developing countries. The remaining 1mn farmers are large farmers from both industrial economies such as Canada and the USA and developing

[1] Accepted as a valid application, 24 August 2007 www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1178620787403.htm)
[2] www.ncga.com/biotechnology/search_hybrids/know_where.asp

economies such as Argentina. Reportedly, the year 2007 marks the first year when the accumulated number of farmer decisions to plant biotech crops has exceeded 50mn (James, 2007). The five principle developing countries that have adopted commercialised GM crops - i.e. India, China, Argentina, Brazil and South Africa - are largely dependent on agriculture and have seen a rapid increase in the area of GM crops these past years. A recent survey of the global impact of GM crops for the period 1996-2006 by Brooks and Barfoot (2008) estimates the global net economic benefits to GM crop farmers in 2006 at USD6.94bn; accumulated benefits during the period 1996-2006 are estimated at nearly USD34bn, with USD16.5bn for developing economies and USD17.5bn for industrial countries. According to Brookes and Barfoot (2008: 7), the largest gains in farm incomes have arisen in the soybean sector, where the additional income generated by GM herbicide tolerant soybeans in 2006 has been equivalent to adding 6.7% to value of the crop in the GM growing countries, or adding the equivalent of 5.6% to the value of the global soybean crop. By 2015, the number of farmers adopting GM crops could - according to the ISAAA (Cf. James, 2007) - increase up to ten fold to 100mn farmers or more, with a strong growth in Asia and continued growth in the Americas. The economic advantage of growing GM crops is a strong incentive for further growth of the GM area.

3.4 Exporters

Exporters of maize and soybean products to the EU have to take measures in order to: (1) prevent that shipments which are labelled conventional get contaminated with traces of GM varieties; and (2) ensure that no shipments get contaminated with traces of GM varieties that are not authorised in the EU. These measures are often referred to as identity preservation (IP), which is the system of crop or raw material management which preserves the identity of the source or nature of the materials.

Measures and costs of IP can be distinguished according to different phases:

- pre-farm: plant (seed) breeding, seed multiplication, seed distribution;
- farm-level:
  - planting: plant the specific seed product, clean planting equipment, avoid cross-pollination, keep accurate records of plantings;
  - harvest: clean combine prior to harvest;
  - storage: clean on-farm storage bins;

- transport: clean lorries/wagons prior to transporting IP crops, clean storage bins prior to delivery of IP crops, ensure there is no co-mingling during the loading or unloading process, sample and test each load, ensure correct delivery of the IP produce;
- further storage: measures and costs comparable to on-farm storage;
- processing: ensure storage tanks are clean prior to use, sample and test each processing batch, clean the processing machinery;
- distribution: ensure that IP products go to the correct end user;
- labelling: ensure correct labelling.

Few empirical studies are available on the economics of IP. The study of Buckwell et al. (1998) gives a good insight in the measures taken by exporters and also provides information on some specific cases (e.g. conventional soybeans for the Japanese tofu market and conventional soybeans for an EU food manufacturer). However, since this study was conducted ten years ago, limited value should be attached to the costs of IP measures presented in this study. A separate study by the Economic Research Service (ERS, 2000) of the USDA estimated the costs of segregation of conventional soybeans and maize in the US, based on known estimates from specialty (niche) market segments of oilseeds and grains. These amounted to approximately 24% of the average farm price for maize at the time, and between 9% and 14% for soybean (Lin and Johnson, 2004).[1] The relevance of such estimates for current considerations is not clear though, given the age and also limited amount of the underlying empirical data. Nonetheless various studies in the academic literature, particularly those that have considered the possible introduction of GM wheat in North America, have used these estimates as a basis or as a benchmark in further (largely hypothetical) analyses.[2] But even the earlier ERS study noted a wide variability of costs according to handler and location. In addition, these costs are likely to change, even in absolute terms, over time as they depend on both relative market sizes as well as organisation learning and efficiency (e.g. Kalaitzandonakes et al., 2001). Note also that such studies have not been explicitly concerned with the more recent EU policy and threshold requirements, nor have they addressed the costs of IP for the specific case of varieties not authorised at all in export destination countries.

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[1] These estimates included costs of segregation and IP at farm-level, during grain-handling until delivery to export destination ports

[2] For example, Moschini et al. (2005), Moschini and Lapan (2006), Wilson and Dahl (2005), Wilson et al. (2008).

The next section describes three cases where measures were taken to prevent contamination of exports by traces of unauthorised GMOs.

1. Argentina

Between April 2007 and March 2008 maize exports from Argentina to the EU were temporarily suspended, due to the fact that Argentinean maize exports were contaminated with the GA-21 maize event, which was not authorised for use in feed in the EU. The Argentinean government took some measures in order to continue the Argentinean maize exports to the EU (ban on sowing and trading GA-21 seeds, sampling and certifications of shipments), but it turned out that the presence of GA-21 in maize shipments could not be ruled out. The import ban for Argentinean maize resulted in a price increase for non-GM maize. Normally the premium for non-GM maize is USD50 per tonne, between April 2007 and May 2008 it was USD80-100.[1]

Soybean exports from Argentina are regulated through the Argentine Oil Industry Chamber (CIARA). No information is available on IP measures taken by Argentinean soybean exporters. However, since almost the entire Argentinean soybean acreage consists of GM-crops, no specific measures will be taken for conventional soybeans.

2. Brazil

In Brazil maize and soybean exports are regulated through the Associação Nacional dos Exportadores de Cereais (ANEC) and the Brazilian Association of Vegetable Oil Industries (ABIOVE) respectively. Buckwell et al. (1998) report on one case of IP with conventional soybeans from Brazil. In this case the main costs were made at farm level. The overall premium was 10% on the farm gate price in order to preserve the identity.

3. United States

In the US maize and soybean exports are regulated by the National Corn Growers Association (NCGA) and the American Soybean Association (ASA) respectively. The introduction and authorisation of new soybean events in the US (e.g. Roundup Ready 2) creates a need for US exporters to take measures to prevent that these new varieties will be exported to the EU (in case of

[1] According to FAO Statistics, the price of Argentina maize (f.o.b.) varied between 160 and 175 USD per tonne in 2007 but rocketed to over 200 USD per tonne in the spring of 2008. The impact of the increase of the premium on the actual price for maize is therefore rather variable.

asynchronous authorisation in the EU). In 2008, measures have been undertaken to ensure IP in seed production for such varieties.[1]
Seed companies in the US have extensive stewardship programmes to ensure that farmers understand which products are not yet approved in the EU. Furthermore various actors in the US grain value chain provide information to help farmers and other chain actors to know the exact requirements.[2]

When a new maize event (DAS-59122-7 or Herculex Root Worm Corn) which was not approved in the EU was introduced in 2006, US exporters and European importers cooperated to establish an Action Plan in order to allow imports of corn gluten feed (CGF) and distillers dried grains (DDG) to continue. CGF and DDG are by-products from the US maize processing industry and are important feed ingredients for the European livestock producers. The Action Plan was developed by the US partners of the chain (Pioneer, Dow AgroSciences, National Corn Growers Association and Corn Refiners Association) in close cooperation with the European Trade Association for Grains, Oilseeds and Feedstuffs (Coceral) and the EU Federation of Compound Feed Manufacturers (FEFAC)

The action plan is composed of two major elements:

- measures to prevent the unapproved EU event ending up in maize by-products designed for export to the EU: this includes measures to inform farmers about the EU status of the event DAS-59122-7 and a request to deliver their harvest to dedicated silos;
- monitoring measures: this includes systematic analysis of each barge of CGF and DDG at the loading point. If a barge tests positive for the event it would then be destined first of all for the US domestic market and, to a limited extent, for non-EU markets. The analysis would be carried out by independent accredited agencies and the results would be provided on a certificate issued by the accredited agency.

After the implementation of the action plan it was expected that exports of CGF and DDG shipments contaminated with DAS-59122-7 would be close to zero. In reality, 45-50% of all samples taken in the US from shipments of CGF and DDG destined for the EU were being tested positive for DAS-59122-7. Since 15 October 2006 all vessels leaving the US carried certificates for negative test results for event DAS-59122-7. But in April 2007 Greenpeace detected the presence of DAS-59122-7 in a shipment of CGF in the port of Rotterdam. In May

[1] Communication from the American Soybean Association (ASA).
[2] See for example www.ncga.com/biotechnology/know_where/index.html

2007 two more vessels with shipments of CGF and DDG were tested positive for DAS-59122-7, even up to 23% in a shipment of DDG. This shows that the action plan did not function properly and between May 2007 and September 2007 (when event DAS-59122-7 was authorised in the EU) almost no exports of CGF and DDG from the US to the EU took place (COCERAL and FEFAC, 2006; FEFAC, 2007, communication Dutch VWA[1]).[2]

Costs for testing US exports of CGF and DDG for Herculex have been estimated at approximately USD1mn (on an annual basis) drawing on experiences in 2006 and 2007.[3] Extrapolating according to volume, this would imply annual costs of about USD3mn for soybean exports to the EU for unapproved events. According to calculations by the US Soybean Export Council (USSEC), testing costs incurred by US exporters could be easily exceeded by losses if it were determined that such shipments should be destroyed, which was not the case for Herculex (USD3-10mn per detained shipment). For soybean, such losses might be expected to be roughly three times such amounts, based on the ratio of soybean to maize prices. Hypothetical estimates by USSEC for costs incurred by US grain traders then amount to between USD27 and 90mn for combined costs of testing, demurrage and destruction of soybean for shipping the post-2009 season.[4] Such considerations could make US growers more reluctant to participate in the IP production chain and/or increase the stringency of IP demands from the US grain industry. It may be difficult though to extrapolate the risk of disruption from maize to soybeans, given various differences between the crops (cross- versus self-pollinating) and their stewardship programmes. Nonetheless USSEC has indicated that many US soybean exporters might find the risk of incurring such costs as unacceptable given their narrow profit margins.

3.5 Importers

According to the European feed and food industry, the (upcoming) introduction of new GM events in maize and soybean exporting countries such as Argentina, Brazil and the US can lead to trade interruptions when the new events are not yet authorised in the EU or the zero tolerance regime is not modified. However,

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[1] Food and Consumer Product Safety Authority.

[2] See also paragraph 2.3.

[3] Email communication with Kimball Nill, US Soybean Export Council and Thomas Redick, Global Environmental Ethics Counsel, September 26, 2008.

[4] A portion of these costs of demurrage and destruction could also fall on EU importers.

it is difficult to assess whether large trade interruptions will already occur in the next coming seasons. When problems will occur, it will be most likely in the soybean sector, since for maize the EU is almost entirely self-sufficient and there are a number of exporting countries (e.g. Brazil and Canada) from which conventional or EU approved GM maize can be sourced.

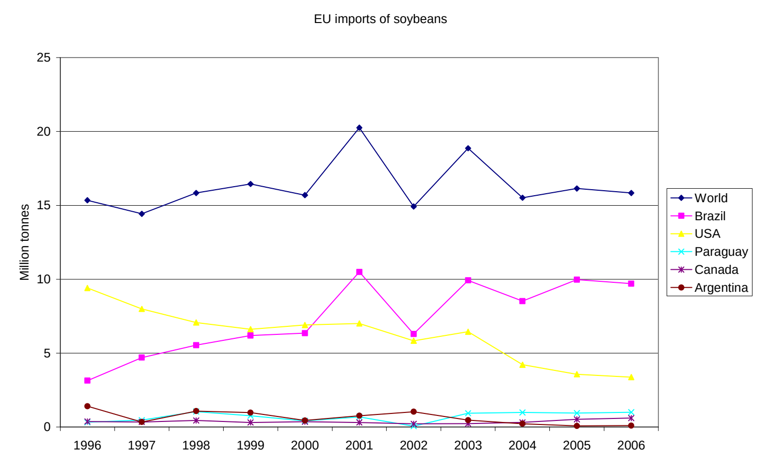
As for soybeans, the first problems could occur with imports from the US after the introduction of the Roundup Ready 2 Yield (RR2) soybean. However, Figure 3.1 on the EU imports of soybeans in the period 1996-2006 shows that soybean imports from the US have been decreasing in the last ten years. In 1996 the US was the largest supplier of soybeans to the EU (9.4mn tonnes), but in 2006 it exported 'only' 3.4mn tonnes[1] (22% of total imports). Brazil is now the largest source of soybeans for the EU, with a market share of 62% (9.7mn tonnes) in 2006. At the same time the figure shows that, with the exception of 2001 and 2003, total EU soybean imports have been relatively stable and do not show an increasing or decreasing trend. Bearing these figures in mind, the introduction of the RR2 variety in the US might have some consequences for the EU imports, but problems will be more severe when Brazil adopts the next generation of soybeans. It is expected that this will still take a few years.

While the EU imports of soybeans are relatively stable at around 16mn tonnes per year, the import of soybean meal has been steadily increasing from 17mn tonnes in 1996 to 27mn tonnes in 2006 (see Figure 3.2). Since 1999 (with the exception of 2001) Argentina has been the major source for European soybean meal, with Brazil being the second supplier. In 2006 Argentina (13.8mn tonnes) and Brazil (7.2mn tonnes) together accounted for 80% of European soybean meal imports. While China is becoming a major competitor for imports on the international soybean market, this does not go for soybean meal. China imports mainly beans, which are then crushed in China. For the EU the soybean meal imports are more important and in this segment there are few competitors for imports. Of the three main exporters, Argentina is the one that exports mostly processed products, while Brazil and the US also export large quantities of beans. The US is also a large consumer of soybean products itself. Current export policy in Argentina also makes exports of processed soy products more profitable, since export taxes on beans are higher than on soybean meal. Therefore the current policy in Argentina makes that soybean meal exports is

[1] According to the Dutch Product Board for Margarine, Fats and Oils, US soy can be of particular importance during the period when, due to differences in harvest season, no Brazilian soy is available (December/January).

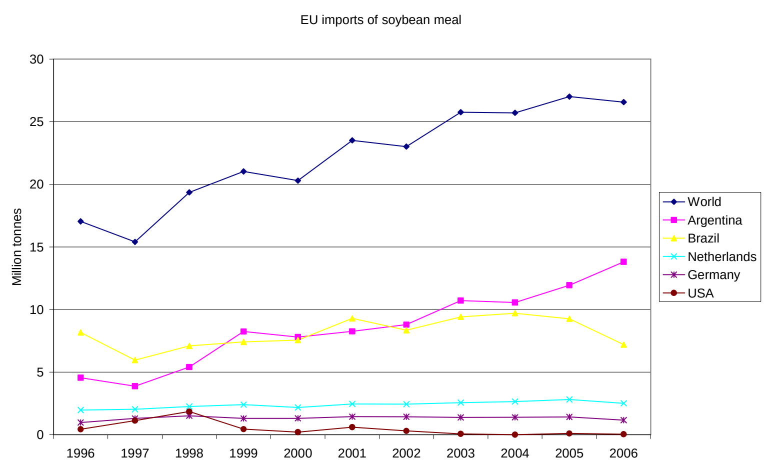
most profitable and with the EU as the single most important destination, it is highly likely that Argentina will take the EU-demand for authorised soybean into account.

Figure 3.1 EU-25 imports of soybeans, 1996-2006



Source: United Nations Statistics Division, data processing by LEI.

Figure 3.2 EU-25 imports of soybean meal, 1996-2006



Source: United Nations Statistics Division, data processing by LEI.

3.6 Feed industry - livestock sector

Estimates of extra costs

According to a study of the European Feed Manufacturers' Association (FEFAC) the current problems with US maize imports due to zero tolerance and the unacceptable risk of cross contamination will cost the EU livestock sector an extra of 1,575bn euro in the 2007/08 season. These costs consist of extra costs due to direct substitution of maize and CGF/DDG imports (865mn euro) and indirect costs due to feed import restrictions (710mn euro). However, actual extra-costs may differ from region to region within the EU. Countries that use large amounts of CGF and DDG - such as the Netherlands, Germany, Ireland, Portugal, and Spain - will see a disproportional cost increase.

In case of soybeans the extra costs for the EU livestock sector in the 2008/09 season could be even higher, depending on the tolerance rate for non-EU-approved varieties. If the tolerance rate is 0.5% or higher, extra costs will be 500mn euro. If the tolerance rate will be 0.1%, the extra costs will be 2.7bn euro. But if the current zero tolerance regime remains unchanged and no imports are possible, extra costs could rise to 200bn euro (Döring, 2008). However, it is unlikely that all three main exporters (Argentina, Brazil and the US) will switch to the new varieties on the short term.

Cost increases for the EU livestock sectors with respect to substituting DDG and CGF are reported to be the sole result of the EU's zero tolerance policy on not (yet) EU approved GM events. There would be ample supplies of DDG - a by-product of bioethanol production - in the US. But now that the EU has largely halted the imports of DDG and CGF out of fear that it could contain traces of not (yet) approved GM events, the US has found itself unable to export these by-products to other buyers. Asian countries appear to be unfamiliar with the use of these products in feedstuffs for their livestock.

EU demand for protein rich feedstuffs (in particular soybeans and soybean meal) is substantially higher than can ever be produced within the EU. The EU imports about 77% of its protein needs; the EU's degree of self sufficiency in protein rich feedstuffs is around 23% (Cf. Fefac, 2007: 6). According to a study commissioned by DG-Agri (2007),

> 'maize imports that are potentially affected by the presence of EU-non approved GMOs could be replaced by maize from the EU-27, by other domestic cereals, or by imports from other trade partners.'

Currently, maize imports into the EU-27 correspond to 4-7% of EU-27 production. EU imports from potential GM origins (Argentina, Brazil and USA) accounted for 45% (or 1.3mn tonnes) of total EU imports in 2006. Hence, interruption of maize trade is unlikely to have a strong economic impact on future feed impacts and livestock production at the overall EU level. However, there could be substantial economic consequences for certain EU Member States as transport costs may rise.

The DG-Agri study shows far more alarming data with regard to soybeans and soybean meal.[1] Few alternatives exist for the EU-27 to replace these protein rich crop imports. A possible increase in oilseed and protein crops such as field peas, field beans and sweet lupines to provide an alternative for soybean replacement, could replace at most 10-20% of the EU imports of soybeans and soybean meal. EU imports of soybeans and soybean meal have stabilised in recent years at around 34-35mn tonnes of soybean meal equivalent (DG-Agri, 2007: 5). The principle suppliers to the EU are Argentina and Brazil; the share of the United States has steadily declined since 2002 (from 6.0mn tonnes in 2002 to 2.5mn tonnes in 2006), while that of Paraguay has been increasing (0.6mn tonnes in 2001, to 0.9mn tonnes in 2006). The EU imports of soybeans and soybean meal originate to nearly 100% from the USA, Brazil and Argentina (Cf. Fefec, 2007: 6).

An impact assessment of an interruption of soybean imports into the EU due to the presence of unapproved GMOs has been calculated in the by DG-Agri (2007) commissioned study. Three possible scenarios were evaluated: a minimal impact scenario; a medium impact scenario, and a worst case scenario. According to the DG-Agri study, there is a real possibility that the medium and worst case scenarios could materialise.

Within the medium impact scenario, an import deficit of 9.9mn tonnes of soybean meal equivalent, results in an expected rise in feed expenditure by 23%. The EU pig price would rise by around 10%, beef imports would increase by 13% and beef consumption rises as a result of higher price projected for pork and poultry.

The worst case scenario concerns an interruption of US, Argentinean and Brazilian soybean/meal imports would leave an import deficit of 32.3mn tonnes in soybean meal equivalent. This scenario will result in a rise in feed expenditure by 600%. The EU will become a net importer of pig meat. EU poultry imports grow significantly. Domestic poultry consumption would drop. Beef imports would fourfold and demand for beef meat expands.

[1] See also box and appendix IV for more details regarding this study.

The next generation of soybeans to be commercialised in third countries is expected in 2009.[1] Based on current experience, it is to be expected that EU approval for import and processing for this new GM soy event will not be given by then.[2]

Trade problems in the past

In the past few years there have been a handful of cases where traces of non-authorised GM varieties were found in feed and food products. Table 3.3 gives an overview of the main cases.

Table 3.3	**Main incidents with impurities found in EU-import, 2005-2007**			
Event	**Crop**	**Origin**	**When**	**Cause**
Bt-10	Maize	United States	March 2005	Accident with research GMO
Bt-63	Rice	China	September 2006	Not authorised (also not in China)
DAS-59122-7	Maize (CGF and DDG)	United States	May 2007	Asynchronous authorisation
GA-21	Maize	Argentina	April 2007	Not authorised for use in feed
LL-601	Rice	United States	August 2006	Accident with research GMO

Only in case of the LL-601 event the Dutch Food and Consumer Product Safety Authority (VWA) acted on the basis of a decision by the European Commission, which prescribed that all costs of sampling had to be paid for by the importers. In this case the importers had to pay about 20 euros/tonne for sampling. Results were available after two days. In all other cases sampling is paid by the authorities. Generally the VWA takes samples of about 10% of all shipments. In the case of the DAS-59122-7 event this was raised to 25%.

It is important to notice that in only two of the fives cases (DAS-59122-7 and GA-21) the cause of the import problems was related to asynchronous authorisation. At the same time no problems related to asynchronous authorisation have been reported for soybeans.

[1] In 2009, there will be a controlled commercial release of Roundup Ready 2 Yield soybeans on up to 2mn acres in the US, followed by a full-scale product launch in 2010. See: www.roundupready2yield.com/Default.aspx.

[2] The Standing Committee on the Food Chain and Animal Health, in its meeting on 29th September 2008, did not reach a qualified majority regarding the approval of RR2Y.

3.7 Food industry

Demand for and current availability of non-GM soybeans

The oil and other soy ingredients used by the food industry are almost entirely derived from conventional soybeans, as the majority of players within the food industry prefer to avoid the use of GM soybeans.[1] The food industry has, if possible, changed recipes to avoid the use of soy. Use of palm oil by the food industry for instance increased, as there are no GM varieties of palm oil. However, substitution is not always possible and depends on the desired characteristics of the food ingredient.

Brooks (2008) estimates the demand for conventional soybean and derivative use in the EU at 10% of total use. Demand for conventional (refined) soy oil in the EU was 0.3mn tonnes in 2006/07 to a total of 1.1mn tonnes used by the food industry (Brooks, 2008). A little less than a quarter of EU demand for soy oil is therefore conventional soy oil.

Assuming that all beans used in the EU should be conventional - based on the assumption that all beans and its derivatives are used in the food industry - demand in the EU for conventional soybeans would be around 16.0mn tonnes per annum. This is approximately 7 to 8% of global production of soybeans. The EU is clearly not a very big player in the market. Presently Brazil is the only major supplier of conventional soybeans to the EU. It is doubted if sourcing of conventional soy will remain possible in the future, as experts in the industry expect that availability will rapidly decrease. Sourcing of conventional soy would require full proof IP.[2] However, even with such a system, impurities in the shipments with GM soy events cannot entirely be excluded. If these impurities are caused by authorised EU GM soy events, and the impurities are below the 0.9% level, no labeling is required as the soy shipment can still be used as conventional soy. However, if the impurity concerns a GM soy event not (yet) approved by the EU the zero tolerance level applies, necessitating refusal of the shipment. The zero tolerance level of the EU is perhaps more of a problem than the sourcing of conventional soy.

Cost implication of a low-level presence of non-EU-authorised events

CIAA (2007b) has described what happens when an incident (low-level presence of unapproved EU events) occurs. In case of such an incident, there will be several costs at different stages:

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[1] All derivatives from soybeans require labeling if they are produced from GM soybeans.

[2] This is further discussed in chapter 4.

- costs prior to first processing (in the port and silo) (e.g. analysis and cleaning);
- costs to first processors;
- costs to industry (second processing) and retail (e.g. recall, supply problems);
- costs to the consumer;
- costs in the aftermath (e.g. administrative and legal costs).

Two cases will be discussed in more detail below.

Case 1: LL-601 rice (2006)
The presence of the not EU approved LL-601 event in shipments from the US to the EU in September 2006 caused large problems with rice imports from the US. An estimated amount of 10,000-20,000 tonnes was impacted. Total costs amounted between 3.5 and €7.5mn per miller. These costs are built up from different categories (cost per miller):
- testing and cleaning of plant equipment: €20,000-€40,000;
- products withdrawal: €600,000-€800,000;
- replacement of affected stock & arrangements for future supply: €400,000-€600,000;
- legal cost: €20,000-€100,000;
- adverse impact on brands/company reputation: €1,000,000-€2,500,000;
- financial charges: €200,000-€400,000;
- compensation paid outside insurance policies: €500,000-€1,750,000;
- staff time: €100,000-€250,000;
- loss of profits: €700,000-€1,000,000;
- Total: €3,540,000-€7,440,000.

In total 15 millers were affected, with total costs between 52 and 111mn euro.

Case 2: possible future soybean events
In case of an imaginary incident with soybean imports, assuming one shipment and fifty companies involved, costs could range between €82 and 156mn. These costs include costs for testing stocks, financial charges, staff time and legal costs. Costs related to replacing stock and arranging future supply, cleaning of factories, brand/company reputation loss and compensation not covered by insurance are excluded (CIAA, 2007b). If however the GM material is

found at a later stage in the processing, costs could be over €1bn.[1] This is due to the fairly low incorporation rates of soy-based derivatives in many products. For instance lecithin, a secondary derivative of soy oil, is used widely by the food industry as an emulsifier. The incorporation rate is overall lower than 1% (ranging between 0.3% and 0.5% for most products), so a little goes a long way and would affect many products. However, the probability of such an incident (contamination of lecithin) is not very high, as prior tests, screening and operation of IP supply chains should minimise this chance (Brookes, 2008:35).

Cost implications of the use of conventional soybeans and its derivatives
According to Brookes (2008) - whose analysis is largely based on interviews with companies in the EU soy derivative and food manufacturing sectors - conventional soybeans were 2 to 10% more expensive than GM soybeans in the period around the turn of the century. The price differential for soy oil ranged from 15 to 25%, for lecithin 60 to 90%.[2] How this affects the costs strongly depends on the product recipes. For some products, like margarine, incorporation rates can be quite high, resulting in significantly higher additional costs for the raw materials. For many other products, with low incorporation rates, additional costs are very small.

The price differentials between conventional soy and GM soy have increased the past years, for soybeans price gaps of 5 to 17% can be noted nowadays. For oil the price difference has not changed, for lecithin it has increased to 50 to 100%.

An underpinned assessment of the impact for the food industry requires further research. This research should cover questions like the possibility to further substitute soybeans and its derivatives by other ingredients, lessening the dependency on conventional soy. Another important question is how the current rocketing use of several oils for the production of bio fuels will influence prices for different oils. This question is particularly relevant for palm oil, as this oil is very suitable both for use in the food industry and as bio fuel.

[1] Extrapolition from lecithin to the whole sector (CIAA, 2007).

[2] The analysis of Brookes focuses on soybeans and two derivatives, soy oil and lecithin.

4 Future possibility of conventional production

4.1 Introduction

Chapter 3 explored the effects of the current EU policy on GMOs assuming that the use in the EU of EU-approved GM raw materials would not change but would remain more or less the same. This chapter explores the impact of a 'GMO-free' scenario, assuming that the food and feed chain in the EU wish to avoid all use of GM raw materials. To this end, the chapter tries to shed light on the question whether this is possible by first assessing the production potential of 'conventional' crops. In addition, the chapter tries to shed light on the costs attached to conventional products and the demand for conventional raw material.

4.2 Production of conventional soy and maize

Soybeans

The production and trade of soybeans in the US (94%) and Argentina (99%) is almost entirely transgenic. In the US the conventional segment is quite small (niche market). Exports of conventional soybean products from the US are almost entirely limited to the tofu and natto markets in Japan, under tightly controlled Identity Preservation (IP) systems. However the adoption rates of GM soybean varieties in different regions show quite some differences. In Nebraska and South Dakota the adoption rate is 97%, but in Michigan (84%) and Illinois (87%) the rates are still well below 90% (USDA statistics). Soybean production in Canada is also mostly transgenic.

According to the Organic & Non-GMO Report Argentina and Canada had some 150,000ha of GMO-free soybeans left in the 2006/07 season. In the US this was 2.71mn ha. The current estimations of the GM soybean acreage in Brazil are about 60-65% of total acreage, but illegal use of transgenic seeds makes it difficult to make a good prediction of the development of GM acreage in Brazil in the coming years. Presently, Brazil is the only large exporter of conventional soy considered relevant for the EU. Brazil was a relatively late adopter of GM soybeans. The cultivation of GM soy was not legalised before

2002 in Brazil, although illegal plantings had been taking place since 1999, with an estimated acreage of 1.400.000ha. In comparison, the US and Argentina have known large-scale cultivation of GM soybeans since 1997. Nevertheless, the GM ratio of soybeans in Brazil has risen from 10% in 1999 to 64% in 2007. Surely the GM acreage in Brazil will rise, but whether Brazil will reach 80% within two or ten years is difficult to predict. In 2004 the Governor of the Brazilian state Parana tried to keep his state GMO-free, but he was sanctioned by the federal agricultural minister and the federal court. This shows that there are some parties in favour of GMO-free soy in Brazil, which currently produces around 20-25% certified conventional soybeans (Roseboro, 2007). The third largest soy producer in Brazil (IMCOPA) produces 'entirely GMO-free' (defined as less than 0.1% contamination) (IMCOPA, 2007). In western Mato Grosso, the largest soy producing state in Brazil, there is an export corridor for 100% conventional soybean varieties (AgBiotech Reporter, 2008).

The commercialisation pipeline of soybean biotech events (see paragraph 3.2) shows that one may expect a steady pipeline of new biotech events for soybean nearly every year, starting with the Round-up Ready 2 Yield variety (MON 89788, Monsanto). After the seed multiplication phase planned in 2008 in the US, this new Monsanto soy event is expected to be cultivated by as much as half of all US soybean farmers in 2009 - the first year of commercial cultivation.[1]

Liberty Link (A2704-12, Bayer) and Optimum Gat (356043, Pioneer) are expected to see the seed multiplication phase in 2008 and 2009, respectively, with commercial harvests starting around 2009/2010. Experts in the field expect that from there, it might take several months to a year before seed multiplication will also start in Argentina, Brazil, Paraguay and other South American countries. As from that moment on, soy imports from these countries to Europe run a reasonable risk of containing traces of this new, not yet by the EU authorised soy events due to contamination. It cannot be excluded that the new traits will be found already in the crop harvested in spring 2009, and at the latest in 2010 in Brazil and Argentina.[2] To illustrate the situation, the feed industry refers to the Herculex corn event. Although still in its seed multiplication phase - Herculex corn (DAS 59122-7) was cultivated on approximately 1% of land dedicated to maize in the United States in 2006 - traces found in EU

[1] Expert opinion: RR2 is expected to increase average soybean yields by 7 to 11%, creating approximately USD35-65 of incremental yield value to farmers, compared to the first generation of Roundup Ready soy. This can be expected to make the use of RR2 quite attractive to US farmers.

[2] This may become reality even without official authorisation being granted for the new traits in these countries. The experience gained with the first variety of GM soybeans shows that it cannot be ensured that the new traits will not be cultivated illegally.

imports spoilt the export of maize and maize co-products to the EU (see paragraph 2.3 for details).

Maize
Within Europe, there are still ample possibilities to purchase GMO-free maize. In general, the EU is largely self sufficient when it comes to maize production. But in times when grain yields and stocks are low, the EU might have to import additional maize. This has been the case in 2006, when EU maize yields reached exceptional low levels. Non-GM maize had to be imported from Brazil at a price increase of €50 per tonne, compared to US maize.[1] Brazil is the only country that is presently able to deliver conventional maize to a considerable extent, as Brazil has not yet approved the commercial planting of GMO maize. Hence, also the food and starch industry in the EU is purchasing maize from Brazil. Reportedly, Brazil is now importing maize from Argentina to feed to its livestock, in order to be able to profit from it sales to EU for non-GM maize (Cf. FEFAC, 2008). However, the National Biosafety Commission has recently given its approval for the commercial cultivation of two new GM corn varieties (Roundup Ready 2 and GA21) (greenbio.checkbiotech.org/news/2008-09-23/Brazil_government_agency_approves_new_GMO_corn_seeds/). It depends on the adoption rate of these new GM varieties how long Brazil will be able to supply the EU with conventional maize.

GMO-free guarantees not watertight
According to experts from the food and feed industry, guarantees as to 100% conventional soybeans (and soybean products) and maize (and maize by-products) will increasingly represent a mirage. Especially the guaranteed sourcing of conventional soy is considered to pose problems. Although conventional soy may still be available in some amounts from Brazil - though at additional costs of up to €80 per tonne - the availability is expected to rapidly decrease in the coming two years. According to FEFAC and experts interviewed, it will not be possible anymore to seek 100% non-GM feed. The feed industry underlines that the possibility of purchasing non-GM soy is not so much a matter of paying 'premium' prices, but by far and foremost a matter of availability in the medium run. Europe uses approximately 48mn tonnes of soybeans (equivalent to around 34.7mn tonnes of soybean meal) per year. According to experts,

[1] In 2007, there was a problem with Argentinean maize in which traces of GA21 (at the time not approved for use in feed in the EU) were found. Traditionally, Argentina is the most significant country of origin where the EU purchases its corn from (Cf. Toepfer International, January 2008: 7).

Brazil will be able to deliver around 4mn tonnes a year of guaranteed conventional soy. There is still land available in Brazil to cultivate conventional soy, but whether this land will be used for conventional soybean production depends on a number of factors, including: the trade-off regarding food/feed/fuel; the upcoming and expanding livestock and meat production industry in Brazil;[1] land preservation and biodiversity matters; demand development for conventional soy from the EU, Japan, South Korea, Norway and Switzerland-which are the only regions with any non-GMO demand; and export opportunities with other countries, notably China and other emerging Asian economies. China accounted for 42% of world soybean trade in 2006/2007 (or 28.7mn tonnes), making it by far the number one soy importing country in the world. Soy imports by China are expected to expand even further by at least 5mn tonnes, which represents about 45% of world trading volumes (Cf. Toepfer International, January 18, 2008: 8, 10).

Availability conventional soybeans decreases rapidly

In sum, the global availability of non-GM soybeans and soybean products is rapidly decreasing. The GM ratio of soybean in the Americas - which account for around 87% of total soybean production - is high and still increasing, implying that the availability of high quality conventional soy is sharply declining. The only options to ensure that conventional soy will still be available for Europe in the nearby future are backward integration into the soybean chain to establish full proof IP soy cultivation, or contracted soybean production. The first option is considered too costly in the opinion of feed industry experts, as it would require huge capital investments in land, logistics and processing plants dedicated to the production, transport and processing of non-GM soy.[2]

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[1] Livestock production in Brazil and also Argentina is growing rapidly. According to USDA data, in Brazil alone, poultry meat production rose from nearly 6mn tonnes in 2000 to over 10mn tonnes in 2007. Exports also climbed during that period, from 0.9 to nearly 3mn tonnes. The Brazilian government estimates that poultry meat production will increase to 14.4mn tonnes by 2012, exceeding beef production. Recently, the Brazilian federation of poultry meat producers and exporters (ABEF) announced a newly negotiated trade agreement with India. It is expected that in the first year of this agreement, Brazil will export 300,000 tonnes of poultry meat to India., representing around 10% of total Brazilian poultry meat exports. These developments, with international demand for meat growing rapidly, imply that Brazil will attempt to use all advances in production in order to expand the production of soybeans and soybean meal accordingly.

[2] For the food industry, higher costs could be less problematic. This depends on the share of non-GM soy in specific food products. Food companies use a number of soy derivatives in very small amounts in food. However, for products with higher incorporation rates, additional costs for using certified conventional soy could be significant.

The second option - contracted production of soybeans - might be feasible in the short term, but is expected to be increasingly infeasible in the medium run as the GM ratio in Brazil is likely to increase, and with it also the risks of contamination.[1] Yet, in the context of IP and risks of contamination, Bertheau and Davidson (2006: 9) mention that some Latin American countries such as Argentina, with very large agricultural surfaces and growing well developed IP systems, will be able to apply large buffer zones, with the objective that the percentage of adventitious presence of GMOs can be held extremely low (<0.1%). In their opinion, shipments should then have no problem in complying with EC regulations.

4.3 Demand for conventional raw materials

Feed industry

From expert interviews with actors from the Dutch and European feed industry, it was gathered that non-GM feed (that is, feed with unintended traces of in the EU approved GM events up to a threshold of 0.9%, meaning there is no labelling requirement) is still relevant in the following sectors: (i) the organic sectors; (ii) the fish feed sectors (in particular soy and corn gluten (60% protein); (iii) in the pet food industry; and (iv) some specific meat production lines in the poultry sectors (broiler sector).

According to the feed producing industry, the demand for non-GM compound feed is rapidly decreasing in the Netherlands and other European countries. One of the main causes mentioned is that livestock farmers are unable to get a return for their extra feed costs out of the market. For meat, eggs, milk, and dairy products obtained from animals fed with genetically modified feed no labelling is required. Consequently, consumers cannot differentiate between products derived from, or containing, animal products from animals that were fed with non-GM feed, and products derived from animals fed with feedstuffs labelled as containing GMOs. An exception is Germany, where food from animals like meat, milk and eggs can - on a voluntary basis - be labelled as 'ohne Gentechnik' as long as the feed, along with a number of other requirements, contained less than 0.9% EU-approved GMOs.[2]

[1] Note that the zero tolerance policy in the EU might be the real problem here.

[2] New legislation for labelling of 'GM free' animal products was passed in the Bundestag in January 2008. This new legislation is however not yet approved by the European Commission.

FEFAC (2008) estimates that on average, 85% of all EU compound feed is labelled as containing GMOs. In the Netherlands, Spain, Portugal, Slovakia, the Czech Republic, nearly 100% of the compound feed is labelled as containing GMOs (with the exception of organic feed). In Belgium and Germany, this percentage is around 95%. In Austria, approximately 90% of all compound feed fed to pigs and poultry is labelled as containing GMOs, yet none of the feed fed to dairy cattle is labelled as containing GMOs. For the United Kingdom and Italy, a percentage of 90% applies, whereas in France about 70% of all compound feed is labelled as containing GMOs.

Food industry
Demand of the food industry for conventional soybeans appears to be constant over time. Nearly all companies within the food industry avoid the use of GM products. The same goes for most supermarkets who implement non-GM policies as well, according to a report by Greenpeace (2005).

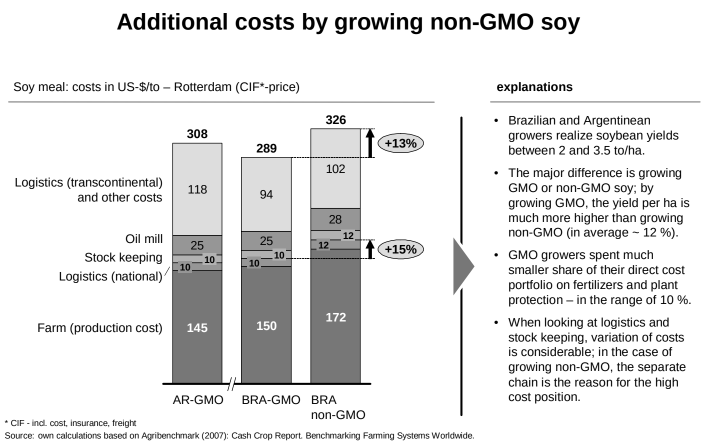
It is unclear whether demand for conventional soybean will decline in (some Member States of) the EU or will remain the same. This will depend strongly on the public opinion regarding GM food. Reportedly, several retail chains in the UK and France have already announced their intention to change their policy regarding GMOs (Cf. Toepfer International, January 18, 2008: 8).[1] Price developments of conventional products - compared to GM varieties - might play a role as well. It may be assumed however that for many food products - although the premiums are not being paid by the market - the higher price for the conventional raw material will hardly affect the consumer food price due to the often low incorporation rates.

4.4 Cost implications of the use of conventional raw materials

Figure 4.1 presents the additional costs of growing non-GM soy (Agribenchmark, 2007). The competitive edge of GM soy meal over conventional soy is significant. The major differences are costs for IP and higher costs of growing non-GM soy. Note that the level of price increases also depends on the tolerance thresholds. Costs can be expected to decrease

[1] In the UK a campaign recently started on internet, for keeping UK supermarkets GM-free. According to the website (http://prismwebcastnews.com/2008/08/22/campaign-for-keeping-uk-supermarkets-gm-free) 'the GM-foods issue in the UK is again in the spotlight. Pressure from the Government and the biotech industry is making the supermarkets think seriously about banding together to introduce a united pro-GM front'.

Figure 4.1 **Additional costs by growing non-GM soy**



substantially when thresholds for traces of GM maize and soy events that are considered save by the EFSA and that are still pending for approval in the EC, are set at higher levels. A consequence of the zero tolerance thresholds for the presence of GMOs not yet approved in the EU would be that in the near future imports of both GM soy and conventional soy from exporting countries where new GMOs are under development will be threatened, and expected costs will increase more than substantially. This, however, depends on the premium growers receive for growing GMOs approved in the EU, compared with the expected increase in yield from new generation soy varieties.

Brazilian and Argentinean growers realise soybean yields between 2 and 3.5 ton/ha. The major difference is growing GM or non-GM soy; by growing GM soy, the yield per ha is higher than growing conventional soy (on average 12 %). GM soy growers spend a smaller share of their direct cost portfolio on fertilisers and plant protection - in the range of 10 %. When looking at logistics and stock keeping, the variation in costs is considerable; in the case of growing non-GM soy, the separate chain is the reason for the high cost position.

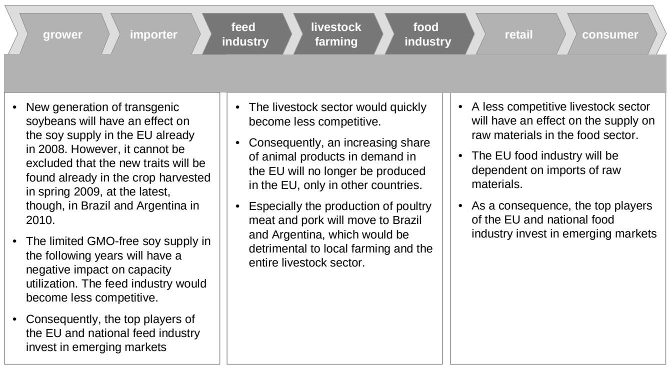
The additional costs in the food supply chain by using non-GM soy/corn can be estimated as follows: lower yields per ha and higher cost in fertilisers and plant protection result in an estimated 15% cost disadvantage for growers, depending on the type of product. Importers face an estimated 13% higher costs for separating supply chains and stock keeping. Depending on the shares of raw material, the feed industry faces an estimated 12% additional costs in compound feed production

The impact of higher feed costs on primary production costs is substantial. Own calculations indicate that feed costs make up for 62% of the production costs of broiler meat and 53% of the production costs of pig meat in the Netherlands. A 1% higher feed price results in an increase in broiler production costs with 0.6%, from 87.9 cent to 88.5 ct per kg. This corresponds with €7,089 higher feeding costs for a farm with 90,000 broiler places. A 1% higher pig feed price results in an increase in production costs with 0.5% from €1.440 to €1.447 per kg, corresponding with €6,000 higher feeding costs for a closed farm with 350 sows.

It should be noted that the calculations presented above refer to the current situation in which the supply of both GM-soy and non-GM soy is not interrupted. In the near future, imports of raw materials from exporting countries where new GMOs are under development will be threatened as a consequence of the zero tolerance thresholds for the presence of GMOs not yet approved in the EU. Future problems are not so much related to extra costs, but to lacking supply of raw materials.

Figure 4.2 presents the risks of the growing dependence on imports and higher feed costs. The limited conventional soy supply in the following years will have a negative impact on capacity utilisation. The feed industry will become less competitive. Consequently, the top players of the EU and national feed industry shift their investments to emerging markets. The livestock sector would become less competitive. Consequently, an increasing share of animal products - especially poultry meat and pork - will no longer be produced in the EU, but imported from countries where the animals are reared on GM feed.

Figure 4.2 **Risks of the growing dependence on imports and higher feed costs**



The EU food industry will become more dependent on imports of raw materials and livestock products. The growing dependence on imports and higher feed costs in the EU will ultimately result in higher consumer prices.

5 Possible contributions of GMOs to sustainable farming

5.1 Introduction

Sustainable farming can be seen as a way of farming that aims to integrate the goals of contributing to people's prosperity, environmental stewardship and profitability, which can be summarised as People, Planet, Profit. These three dimensions of sustainable farming tend to be closely related and are sometimes difficult to separate. A high farm profitability and a cleaner rural environment usually also improves the wellbeing of rural people. Similarly, farming systems that perform well in terms of Profit may have an adverse impact on People and Planet.

Although the negative impacts of GMOs on the sustainability of farming are often emphasised in the public debate in Europe, GMOs indeed have the potential to contribute to more sustainable farming systems in terms of People, Planet, Profit. There is little discussion about the Profit dimension in relation to the cultivation of GM crops. The very rapid adoption of GM crops worldwide in recent years has been driven primarily by a higher farm income obtained from cultivating GM crops, relative to non-GM crops. This is true for large-scale farmers (Brookes and Barfoot, 2006; Qaim and Traxler, 2005), as well as smallholder farmers in developing countries such as India, China and South Africa (Gouse et al., 2006; Morse et al., 2006 and 2005; Bennett et al., 2006 and 2004; Thirtle et al., 2003; Huang et al., 2002). Also the possible contributions of GMOs to the Planet dimension of sustainable farming have been relatively well studied and reviewed (e.g. COGEM, 2008; Brookes and Barfoot 2006), although evidence of the actual contribution of GMOs is often not conclusive. Much less is known about how GMOs affect the People dimension of sustainable farming.

Below we provide a summary of the current and expected contributions of GMOs to reduce the environmental burden of farming (Planet). Furthermore, we acknowledge different types of impact from GM crops on the People dimension and evaluate qualitatively how current GMOs and those in the pipeline can contribute to the People dimension. The contributions of GM micro-organisms in general and those of GM crops enabling a biobased economy specifically have been excluded from this study.

5.2 GMOs contributing to the environmental dimension of sustainable farming

Potentially, the cultivation of GM crops can result in a reduction of the environmental burden from agriculture by:

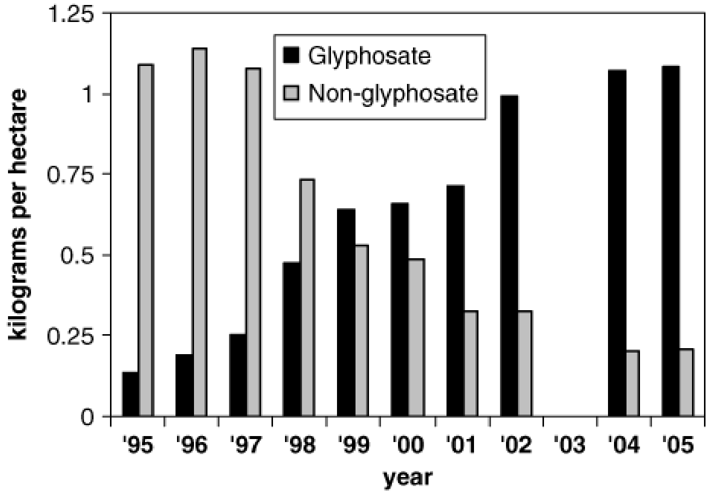
1. Reducing the impact from crop protection agents;
2. Reducing the demand for agricultural land;
3. Stimulating agricultural practices that are beneficial to the environment;
4. Reducing environmental pollution during crop processing after harvest.

1. Reducing the impact from crop protection agents

The rapid adoption of GM crops worldwide can be attributed almost entirely to crops with insect resistance, herbicide tolerance, or a combination of these traits. The current herbicide tolerant crops have traits that allow them to withstand the application of the broad-spectrum herbicides glyphosate or glufosinate-ammonium. Whether herbicide tolerance in crops leads to an increase or decrease in herbicide use is still under debate. While the use of those herbicides against which GM crops are tolerant has greatly increased due to the introduction of herbicide tolerant crops, the use of other herbicides has strongly decreased. See for example the herbicide use in soybean in the US, in 1995-2005, a period in which the contribution of GM soybean to the total soybean acreage increased from 0 to 85% (Figure 5.1).

Apart from the quantity of agro-chemicals applied, also their toxicity should be taken into account. Different agro-chemicals have a different toxicity per amount of active ingredient, as well as a different environmental burden. The Environmental Impact Quotient (EIQ) (Kovach et al., 1992), a universal indicator to assess the environmental impact from agro-chemicals, has been used to compare the impact from different herbicides. Kleter et al. (2008) estimated that for Europe the quantity of herbicides applied to GM glyphosate-resistant sugar beet would decrease, while those on GM soybean would slightly increase, compared with the use in their conventional counterparts. The EIQ associated with these GM crops, was similar or less negative, relative to their conventional counterparts. However, weeds develop herbicide resistance when a herbicide is used exclusively for longer times, as is often the case with herbicide-tolerant crops. As a result, herbicide applications need to be increased or diversified, which usually makes the associated EIQ more negative. This would cancel out any potential environmental benefits of growing herbicide-tolerant crops on the long term, unless suitable alternative weed management systems are available.

Figure 5.1	Herbicide use on soybean in the US, average active ingredient per area treated with herbicides, 1995-2005. Data from NASS (2006)



Source: Kleter et al. (2007).

Insect resistance in GM crops is usually obtained by incorporating a gene from the bacterium *Bacillus thuringiensis* (Bt). Literature on the impact of Bt crops on pesticide use generally points towards a reduction in the use of pesticides on Bt crops and an improvement in the associated EIQ values, relative to their conventional counterparts (Brookes and Barfoot, 2006; Kleter et al., 2007). Global pesticide use (active ingredients) in Bt maize and cotton in 1996-2004 has been estimated to decline with 3.7 and 14.7%, respectively, while the EIQ declines with 4.4% for Bt maize and 17.4% for Bt cotton (Brookes and Barfoot, 2005).

Ongoing efforts in a project called DuRPh to develop a GM potato with a sustainable resistance against the disease late blight (*Phytophthora infestans*) may prove to be valuable to increase the sustainability of potato cultivation. Late blight in the EU causes annual losses of more than €1bn (Haverkort et al., 2008). Moreover, chemical disease control causes a major environmental burden, especially to surface waters. Conventional breeding has resulted in potato varieties with a monogene resistance against late blight, which is likely to be rapidly broken by ever more aggressive forms of late blight. Genetic modification allows the simultaneous transfer of several resistance genes from wild potato varieties into the cultivated potato.[1] The resulting polygene resistance is likely to provide a long-lasting protection and allow a reduction in fungicide use in potato by 50%. While it took breeders several decades to develop a potato with a monogene resistance through conventional breeding, a potato with a polygene resistance, based on GM, is expected to be available within 10 years from the project start (2007).

2. Reducing the demand for agricultural land

GM crops with traits that facilitate crop protection can result in higher crop yields, especially when other crop protection measures are insufficient to avoid biotic stresses. Bt cotton in South Africa and India has reduced pest damage and increased yield in certain circumstances (Qaim and Zilberman, 2003; Smale et al., 2006). Also a GM potato with a sustainable resistance against late blight could significantly increase yields in areas where control measures are not as thorough as in north-western Europe. Some GM traits in the pipeline focus on increasing the yield potential of crops. Anticipated new varieties of glyphosate-tolerant soybean also include a GM trait that increases soybean yield in the field by 7-11%, according to the seed producer Monsanto. Achieving higher yields on an area of land without increasing the environmental burden can be seen as a form of enhanced sustainability, as less agricultural land is required to achieve a similar production.

Moreover, GM crops with tolerance against abiotic stresses, such as cold, heat, salt and drought, or with a higher nitrogen use efficiency are in the pipeline. Seed companies Pioneer and Monsanto expect to have stress-tolerant GM varieties available for commercial use within the next 4 to 6 years. However, some scientists expect this to take much longer, in the light of the complex mechanisms that regulate stress tolerance in plants. GM crops adapted to abiotic stresses have the potential to achieve higher yields than conventional crops, especially under marginal conditions. The area of marginal agricultural soils is likely to increase in the world due to fresh water scarcity, climate change and an increase in the area of arable soil in general. GM crops that assist in increasing yield levels without increasing the environmental burden contribute to the sustainability of farming.

[1] Up to now, most gm crops are the result of transferring genes from one species to another, so called transgenesis. The incorporation of genes from related, crossable species, e.g. the transfer of genes from wild potato plants to cultivated potato varieties, is called cisgenic genetic modification or cisgenesis.

3. Stimulating agricultural practices that are beneficial to the environment
GM crops can have a positive impact on the environment by stimulating certain agricultural practices. The introduction of herbicide-tolerant GM crops has improved the efficacy of chemical weed control with broad spectrum herbicides and reduced the need to rely on soil cultivation and seed-bed preparation to achieve good weed control. As a result, herbicide tolerant crops have facilitated the implementation of reduced or no tillage systems (also referred to as soil conservation systems). These systems can have a number of advantages above conventionally ploughed systems, including: less CO_2 consumption during ploughing, an increased carbon storage in the soil, less erosion and a more diverse soil life. On the other hand, soil conservation systems may result in a higher pressure of certain weeds, diseases and plagues. The Intergovernmental Panel on Climate Change estimated that in northern America, no tillage results in a carbon (C) storage of 300 kg C ha^{-1} y^{-1}, reduced tillage in a storage of 100 kg C ha^{-1} y^{-1}, while conventional ploughing in a loss of 100 kg C ha^{-1} y^{-1}. Brookes and Barfoot (2006) estimated that, globally, conservation agriculture, as facilitated by GM crops, was responsible for the sequestration of 9,423mn kg of CO_2 in 2004. It is difficult to see how the area under conservation agriculture would have developed without the presence of GM crops.

4. Reducing environmental pollution during crop processing after harvest
GM crops can reduce the environmental burden of crop processing. Although very few GM crops in this category are currently commercially available, many GM crops of this type are expected to arrive on the market in the next years. For instance, in the EU a GM potato with solely amylopectine starch is expected to be released in the near future by AVEBE and BASF (BASF Group, 2008). This potato for industrial use does not contain amylose starch, unlike ordinary potatoes. As a result, considerably less energy and chemical additives are required during processing to obtain pure amylopectine, which is the type of starch required for industrial purposes.

5.3 GMOs contributing to the People dimension of sustainable farming

The People dimension of sustainable farming pertains to fair and beneficial farming practices toward labour and the farming community and the region in which farming is conducted. The impact of GM crops on the People dimension of sustainable farming is different for each crop and modification and also depends on the socio-economic context of farming. However, some general tendencies can be observed. Studies from literature primarily provide qualitative evidence of how current GM crops contribute to the people dimension. Many GM crops in the pipeline are likely to have an impact on the People dimension, but this has not been proven in practice yet. No consensus exists which indicators should be used to assess the impact of GMOs on the People dimension. However, such indicators have been applied, or are currently being developed, to evaluate the sustainability of organic farming systems (Tonneijck and De Haan, 2006) and that of soybean production in South America (RTRS, 2008). Comparable indicators can be used in the future to value the impacts of GMOs on sustainability of farming in general and the People dimension in particular.

We have identified four areas where GM can contribute to the People dimension:

1. profit and People;
2. quality of agricultural products;
3. food security;
4. labour conditions.

1. Profit and People

The Profit and People dimensions of sustainable farming are often related, as socio-economic change and people's wellbeing go hand in hand. An important driver behind the rapid adoption of GM crops by farmers worldwide in recent years has been an increased farm income from the cultivation of GM crops, which is likely to impact the People dimension through improved well-being of farmers and their families and possibly also that of farm workers and the wider agricultural community.

The labour required for farming also relates to both Profit and People. Crops genetically modified with the aim to facilitate pest, disease or weed control tend to require less labour than non-GM crops. Herbicide-tolerant GM crops reduce the need for mechanical weed control measures that are usually more labour-intensive than chemical weed control. Bt crops reduce the labour demand for pesticide spraying (Purcell and Perlak, 2004; Bennett et al., 2003). Reduced labour demands associated with the cultivation of GM crop allows farmers to allocate labour to other activities or save labour costs. On the other hand, reduced labour demands can decrease employment opportunities for farm workers. This could be a negative side effect of more efficient production methods enabled by GM crops.

A great deal of the farmers that have adopted GM crops are small-scale farmers in developing countries. According to a survey by ISAAA, 90% of the total of 12mn farmers growing GM crops worldwide in 2007 were small-scale, resource-poor farmers from China, India, South Africa and several other countries (James, 2007). These farmers primarily grew Bt cotton, and smaller areas of Bt and herbicide-tolerant maize and soybean. Also in developing countries, GM seed is usually sold to farmers for a premium price, relative to conventional seed (Gouse et al., 2006; Morse et al., 2005), with the exception of China where GM seed has been developed in the public domain (Huang et al., 2002). The high adoption rate of GM crops indicate that small-scale farmers in developing countries are willing to invest in GM seed, despite higher costs. Lower expenditures on agro-chemicals, higher or more stable yield, and labour savings are frequently mentioned in farmer surveys as the main benefits from the adoption of GM crops (Gouse et al., 2006; Bennett et al., 2006; Morse et al., 2006 and 2005; Huang et al., 2002). All three benefits are expected to lead to a higher farm income and improved livelihoods for small-scale farmers. A great number of GM crop varieties are currently being investigated in developing countries (FAO, 2008). This type of research is supported by governments and the private sector. This indicates that the private sector sees commercial opportunities in the development of new GM varieties aimed at farmers in developing countries. Moreover, this indicates a demand among policy makers and researchers in developing countries for more knowledge on GM crops and an interest in GM as a tool to improve the agricultural sector.

The People dimension of profits from agriculture also concerns the questions which farmers benefit, or benefit more, from GM technologies, and whether some have less or no access at all to the technology. In the developing world in particular, there are concerns that GM varieties will be of disproportionately greater benefit to larger farmers with more resources, as has sometimes been seen with new varieties and technology packages in the past. The limited number of studies and reviews reveal mixed results for GM innovations. In the case of Bt cotton, the benefit for smallholders has been described as 'promising', based on a literature review (Smale et al., 2006). Differences among farmers in access to GM varieties appeared to be related to the institutional framework including whether GM varieties have been developed in the public or private sector, as well as the intellectual property right regime.

The impact of GM crops on the functioning of communities is variable. The cultivation of GM soybean in Latin America has coincided with the destruction of rain forest and the loss of livelihoods of indigenous people in some regions. It is uncertain to what extent this deforestation and loss of livelihoods would have taken place if only conventional soybean varieties were available. In most other cases, the introduction of GM crops had much less dramatic effects on local communities. The introduction of GM crops is likely to cause changes in the local input supplying and processing industries (for instance. a loss of business for local pesticide dealers, see Kambhampati et al., 2005).

2. Quality of agricultural products

There are no reasons to assume that the consumption of registered GM food products is unhealthier than that of non-GM crops. With the regulatory systems in place, the chances that released GMOs are somehow detrimental to human or animal health are very slim. Since the commercial cultivation of GM crops started in the 1990s, no negative health impacts on consumers of GM products have been observed. However, the rapid spread of GM products can be perceived by consumers as a threat to their health and can constrain their freedom to choose to consume GM or non-GM products. This may reduce feelings of well-being among consumers. We will not treat this issue in further detail.

GM can contribute to the production of food products with a higher nutritional value or with other traits contributing to the health of consumers. Although almost all commercially cultivated GM crops are currently intended to make crop production more efficient and do not focus on consumer demands, many of the GM crops in the pipeline have traits that aim to respond to consumers' demands (see also par. 4.1). For example, Monsanto and the Solae Company are currently developing GM soybean varieties that can serve as a cheap source of omega-3 fatty acids (Monsanto, 2008). GM may also be used in the future to increase the health promoting value of vegetables and fruits by increasing the composition and amount of flavonoids in plants (Schijlen et al., 2006; Verhoeyen et al., 2002). The commercially cultivated Bt maize varieties have a secondary effect on the presence of mycotoxins, which are detrimental to human health. As Bt maize is less damaged by maize borers than conventional maize, less opportunities for mycotoxin producing fungi exist to enter the maize plant (GMO safety, 2008; Schier, 2008).

GM is also being applied to tackle serious health problems related to the nutritional status of poor people. An example is the 'golden rice' varieties with increased levels of beta-carotene that assist in alleviating vitamin A deficiencies among poor people (Paine et al., 2005; Zimmerman and Qaim, 2004; Dawe et al., 2002). Vitamin A deficiencies can cause blindness and an increased mortality. Field testing of golden rice varieties in Asia has started in 2007. Other efforts to improve the nutritional value of staple foods, also called food bio-fortification, with GM are ongoing.

Plants are also seen as an alternative for the industrial production of high value materials, such as pharmaceuticals or enzymes. GM plants could take up a main role here. The production of pharmaceuticals in plants is also called 'biopharming'. A great deal of GM plants producing a wide range of pharmaceuticals are currently in the pipeline (COGEM, 2008). Also the possibilities for the production of food additives or biomaterials, such as bio-plastic, through GM plants are under investigation. As it is relatively easy and cheap to upscale plant production, the production of pharmaceuticals or other bio-materials with plants is expected to be more efficient and possibly more environmental friendly than conventional production methods. This could lead to cheaper or new pharmaceuticals and other products for consumers.

3. Food security
If the cultivation of GM crops leads to more efficient production methods, prices of agricultural products for consumers can decrease (as with other more productive agricultural technologies). For example, it has been estimated that the adoption of herbicide-resistant soybean created a USD1.2bn surplus globally in 2001, of which 53% went to soybean consumers (Qaim and Traxler, 2005). Moreover, a better control of biotic and abiotic stresses in GM crops, can result in a more stable production and supply of agricultural products to consumers. Thus, on the long term, GM can contribute to a more efficient and stable food production, which can lead to a higher level of food security for people. This is especially relevant in developing countries where food insecurity is most rampant. Food insecurity is not only detrimental to people's health, but can also lead to social instability.

4. Labour conditions
GM crops with resistance against pests or diseases generally require less or less toxic pesticides than their conventional counterparts reducing potential detrimental health effects from contacts with pesticides. Especially in developing countries, farmers, their families and farm workers are frequently in contact with pesticides during application. A study on the health impacts of Bt cotton among smallholder farmers in South Africa suggested that the reduction in spraying frequency in Bt cotton was beneficial to women who do the spraying and to children who assist in spraying (Bennett et al., 2003 and 2006). Also the number of accidental pesticide poisoning among cotton farmers and their families appeared to decline as the uptake of Bt cotton increased. Similarly, in China, farmers growing Bt cotton are reported to have less health problems due to pesticide use than conventional cotton growers (Huang et al., 2002).

6 Discussion and conclusions

Wide spread cultivation of genetically modified crops

Over the last twelve years cultivation of genetically modified crops has seen a rapid development world-wide. Especially in North and South America the area of genetically modified crops has increased at an unprecedented pace. In the EU the cultivation of genetically modified crops is still rather limited. In contrast, the use of genetically modified crops is rapidly increasing, as the EU livestock industry is highly dependent on the import of soybean products and to lesser extent maize products. The import of the food industry of genetically modified products is less important, due to the avoidance policy of the EU food industry of GMOs.

The lagging cultivation of genetically modified crops in the EU follows among other things from the protracted procedure the EU applies for the authorisation of new GMOs. On average, the procedure can take up twice as long in the EU compared to other countries. This asynchronous EU approval of GM crops, coupled with the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU, has caused difficulties these past years in the import of food and feedstuffs from exporting countries where more GMOs have already been approved or are under development.

With the more widespread cultivation of GMOs that are approved in the exporting countries - notably the United States, Argentina and Brazil - but not, or not yet, in the EU, potential trade disruptions could become more severe, more frequent, and affect more products. Imports may be interrupted, slowed down considerably or come to a halt altogether, as traders may become unwilling to assume the risk of having traces of GMOs not yet approved in the EU detected in their shipments. A number of these incidents (low-level presence of unapproved GMOs) have already taken place in the past.

Impact of the EU zero tolerance policy

As a consequence, European livestock producers face the risk of being cut off from especially high-quality, protein rich feedstuffs that are essential to feed their animals. EU demand for protein rich feedstuffs (in particular soybeans and soybean meal) is substantially higher than can ever be produced within the EU. The EU imports about 77% of its protein needs. An interruption of imports of soybean/meals may significantly decline EU livestock production, leading to substantial disruptions to livestock producers, related suppliers and processors.

Without a sufficient supply of feed ingredients which forces livestock operators to use less satisfactory and more costly alternatives, the competitiveness of EU livestock production will weaken further and European livestock operators will lose market share in domestic and world markets to foreign competitors.

Lower yields per ha and higher costs in fertilisers and plant protection result in an estimated 15% cost disadvantage for growers of non-GM soy. Importers face an estimated 13% higher costs for separating supply chains and stock keeping. Depending on the shares of raw material, the feed industry faces an estimated 12% additional costs in compound feed production. Additional costs for the (Dutch) livestock farming sector as a result of 1% higher feed prices result in an increase in broiler production cost with 0.6% per kg and in an increase in pig production costs with 0.5% per kg.

Given that EU livestock production accounts for about 40% of the total value of agricultural production, a loss in competitiveness of the EU livestock sector is likely to have important implications for agricultural incomes and employment, with considerable knock-on effects in the upstream and downstream industries, and significant increases in meat prices for consumers. Eventually, the EU will need to import its meat from countries where animals are reared on the same feed materials that European producers are not allowed to use.

For the food industry the problem lies in the sourcing of conventional raw materials. Although it may be expected that in the short to medium-term availability of conventional raw material is not likely to pose a problem, the zero tolerance policy could very well be a problem. Even despite IP systems it is very difficult to prevent impurities in shipments. Combined with traceability systems that are improving every year, it is not difficult to imagine the problems the food industry will have sourcing raw material. Another effect will be that non-GM raw material will have to be bought at a considerable cost, as IP systems are quite costly. For a number of food products, with high incorporation rates of the raw material, this could affect the consumer price as well.

The EU's approach of protecting its inhabitants against GMOs not (yet) approved by a zero tolerance threshold is thus projected to come at a significant cost. It will become increasingly costly to be able to 'guarantee' that supplies are GM free or free from not (yet) by the EU unapproved GMOs. Contaminations are hard to avoid and traceability comes at a price. As said, the operation of a zero tolerance threshold for the presence of GMOs not yet approved in the EU has already led to difficulties with the import of raw materials. This report argues that it is likely that in the near future problems will become more urgent. Ultimately, the appropriate level for the threshold can only be determined by balancing estimated cost against the benefits.

GMOs and sustainability

GMOs can contribute to the sustainability of farming in terms of People, Planet, and Profit. The cultivation of GM crops can contribute to the Planet dimension of sustainable farming by: 1. reducing the need for crop protection agents; 2. reducing the demand for agricultural lands; 3. stimulating agricultural practices that are beneficial to the environment; and 4. reducing environmental pollution during crop processing after harvest. The People dimension of sustainable farming pertains to fair and beneficial farming practices toward labour and the farming community and the region in which farming is conducted. Different types of impact from GM crops on the People dimension are acknowledged and evaluated qualitatively: 1. Profit and People; 2. quality of agricultural products; 3. food security; and 4. labour conditions. Quantification of the actual contribution of GMOs to the People dimension is difficult. A need has been identified to develop indicators that can assist in comparing farming systems with and without particular GMOs with regard to their impact on sustainability in general and the People dimension in particular.

Discussion

This report presents an analysis of the current EU policy on GMOs based on desk research and expert interviews. Our results show how this policy of the EU has already led to difficulties with the import of raw materials from exporting countries where more GMOs have already been approved or are under development. This report argues that it is likely that in the near future problems will become more urgent. This could negatively affect the EU supply of raw materials and economic position of the European agricultural and food sector. It must be emphasised that the findings presented here are dependent on underlying behavioural and technical assumptions and on the quality of the available information considered.

The need to simplify the analysis has resulted in at least three important limitations. First, in evaluating the impact of the current EU policy on GMOs, the existing time constraint did not enable full analysis of the impact on the food industry. We did not assess the consequences of the possible redirection of investments by major food companies to non-EU countries on innovation. Second, the possible consequences of shifting consumption patterns from poultry to beef meat were not analysed. Finally, valuation of the benefits associated with conventional production and consumption is outside the scope of this study.

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Appendix 1

Main elements EU-policy regarding genetically modified organisms

Authorisation
Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms (OJ L106, 17.4.2001) and Regulation (EC) No 1829/2003 on genetically modified food and feed (OJ L268, 18.10.2003) are the two main legal acts laying down the Community procedures for the authorisation and supervision of genetically modified organisms, food and feed.

Based on these legal acts, all new GMOs must be evaluated either by the Competent Authority in the Member State (for GMO applications under Directive 2001/18/EC) and/or by the European Food Safety Authority (EFSA) (for applications under the same directive and/or Regulation (EC) No 1829/2003).The purpose of these evaluations is to assess that deliberate release or the placing in the market of GMOs and/or the use of GMOs for food (including feed) does not have adverse effects on the environment, human health or animal health. For the purpose of this report, the focus is on Regulation (EC) No 1829/2003.

Until 1 August 2008, fifty-nine applications for authorisation have been submitted at EFSA (www.efsa.eu.int). Included in this number are six applications for soy events, of which five for use in food and feed and 1 application for cultivation within the EU. For maize there are 9 applications for cultivation of GM events and 26 applications for events to be used in food and feed. For canola there are 3 applications each for cultivation and for use in food/feed.

According to the Community register of genetically modified food and feed, 12 maize transformation events are authorised for use (including stacked events), 3 modified oilseed rape events (including one authorisation with a very limited scope) and 2 genetically modified soy events. The list further includes cotton and sugar beet (ec.europa.eu/food/dyna/gm_register/index_print_en.cfm).

The following tables give a full list of the authorisations for cultivation and use of GM soy, maize and rapeseed in the EU and various other countries. The tables clearly show the gap in approval of GM events between the EU and a number of countries.

Table A1.1	Authorisations for cultivation and use of GM soy a)	
Country/region	**Approval for cultivation**	**Approval for use in food/feed**
EU	0 (1 application)	2 (5 applications)
USA	8	8
Argentina	1	1
Australia	-	3
Brazil	1	1
China	-	1
Japan	5	5
Canada	4	4
Korea	-	1
Mexico	1	1

a) Listed are different GM soybean lines (events) Source: GMO Compass, GMO Database, July 21, 2008.

Table A1.2	Authorisations for cultivation and use of GM maize	
Country/region	**Approval for cultivation**	**Approval for use in food/feed**
EU	2 (9 applications)	10 (26 applications)
USA	22	21
Argentina	9	8
Australia	-	13
Brazil	3	-
China	-	9
Japan	23	27
Canada	22 a)	23
Korea	-	22
Mexico	-	19

a) Among the approvals are five for new types of maize plants. These maize varieties are resistant to herbicides. Such new types of plants require approval in Canada. In contrast, in the EU and the USA only genetically modified plants have to undergo the approval procedure, and not new breeds of plants produced, for instance, by mutagenesis.
Source: GMO Compass, GMO Database, July 21, 2008.

Table A13	Authorisations for cultivation and use of GM rapeseed	
Country/region	**Approval for cultivation**	**Approval for use in food/feed**
EU	- (3 applications)	3 (3 applications)
USA	9	10
Canada	10	10
Japan	11	11
Australia	6	7
China	-	7
Korea	-	6
Mexico	-	4
Source: GMO Compass, GMO Database, 20 March 2008.		

Lengthy procedure

The authorisation procedure in the EU can take quite some time,[1] mainly caused by an unfavourable political climate towards GMOs. For example, the file for authorisation of modified maize DAS-59122-7 (Herculex) was submitted on 27 January 2005, the approval was published in the Official Journal of 31 October 2007.

According to Regulation (EC) No 1829/2003 the EFSA shall endeavour to respect a time limit of six months to deliver its opinion based upon its assessment of the safety of the GMO for which an application has been filed. Within this period, member states' competent authorities are able to provide their comments to the dossier. EFSA has the possibility to 'stop the clock' during this six-months period if questions pertaining to the dossier arise about which the applicant will be contacted and requested to provide the additional information needed to proceed with the assessment. Following the assessment, EFSA will publish an opinion, based upon which the European Commission will draft a proposal for a decision on the pertinent GMO. This is sent to the Standing Committee on the Food Chain and Animal Health.

The representatives of the Member States in this committee have to decide whether or not to authorise the GMO. Until now there has been disagreement within the Committee, as a result of which no qualified majority in favour or against any authorisation has been reached. This has forced the European Commission to bring matters to the EU Council of Ministers, which has a three months period to decide by qualified majority. In the Council as well, no qualified majority has been reached on any authorisation. All authorisations have until now

[1] According to information based on interviews with experts in the field, an authorisation procedure can take up 1,5 years to 8 years, depending on the type of application.

therefore been granted by the European Commission, in line with the procedure which allows the Commission to take a decision in this matter when the Council fails to do so. During the last meeting of Ministers of Agriculture, on July the 15th, the Council again rejected two authorisation proposals for GMOs. One concerned soybean A2704-12, the other cotton LLCotton25; both GMOs had received favourable risk assessments by the EFSA. This disagreement at the level of both the Standing Committee and the Council prolongs the authorisation with at least six months.

Although the procedures for authorisation differ between countries, the underlying principles for safety assessment are harmonised through the Codex Alimentarius guideline for the conduct of food safety assessment of foods derived from recombinant DNA plants (CA/GL 45-2003). All Codex members approved this guideline.

Despite this common ground, no mutual recognition of authorisations exists. Initiatives in this area are however undertaken in the framework of the Codex Alimentarius.

It should be noted there is one important exception to the comparability of principles for authorisation world-wide. This is related to the so-called 'stacked events', hybrids of individually approved GMOs. In most countries, stacked events do not require a separate authorisation procedure. However, the EU and Argentina do require a separate procedure, as these countries view a stacked event as a new transgenic construct.

Zero tolerance policy

One of the key elements in the EU legislation regarding GMOs that negatively affects the EU import of food and feed products is the zero tolerance policy regarding unauthorised GMOs. Unauthorised GMOs that may have been approved for commercialisation in other countries are not allowed in the EU and should be taken from the market, even when these unauthorised GMOs are unintentionally present at a very low level.

Currently the European Commission is working on a technical solution for the zero tolerance problems, by allowing a certain margin when measuring the level of contamination by unauthorised GMOs. A so-called action limit, based on article 11.4 of Regulation (EC) No 882/2004[1] would allow for import of

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[1] Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules.

shipments when the level of unauthorised GMOs found is less than 0.x%. Such an action level could lessen the problem of impurities that lead to the refusal of shipments of authorised GM when even a very slight contamination by an unauthorised GMO has been found. Legal proposals are expected autumn 2008. However, the outcome of this discussion is unclear and the food and feed industry does not expect this discussion will soon lead to an acceptable solution for all parties concerned.

Detection of unauthorised GMOs can be quite difficult, as specific methods to trace these GMOs are not always available. In case of authorised GMOs in the EU, methods for detection, sampling and identification of the transformation event form, among other things, part of the authorisation procedure. Unauthorised and known GMOs may be detected by using the same methods as for authorised GMOs. Unknown GMOs, by definition, cannot be detected and are unauthorised (Bertheau and Davison, 2006:18). In future it is not unrealistic to expect that the possibility to trace unknown GMOs will improve, however this traceability is projected to come at a fairly high cost (Glandorf and Loos, 2007).

Labelling

The EU requires labelling of food or feed that consist of, contain or is produced from GMOs, regardless whether or not the final product contains DNA or protein resulting from genetic modification. The labelling requirement applies to all GMOs that have been approved in accordance with Regulation 1829/2003. However, if products contain GMO traces in a proportion no higher than 0.9% of the food ingredients considered individually, no labelling is required provided that this presence is adventitious or technically unavoidable. This can be the case with accidental contamination of conventional products during harvesting, storage, transport or processing. However, operators, for instance farmers, must supply evidence that they have taken the appropriate steps to avoid the presence of GMOs.

The labelling requirements are intended to provide consumers or other final users with accurate information, enabling them to make an informed choice. In practice however, consumers can buy a conventional product which contains traces of GMOs (below the 0.9% threshold) without being informed about this; they can also buy a product which according to the label is produced from GMOs although the final product does not contain DNA or protein resulting from genetic modification (this is for instance the case with refined oil from genetically modified soybeans). Also, labelling applies to food and feed produced 'from' a GMO. Products obtained from animals fed with genetically modified feed are not subject to the labelling requirements.

Traceability and labelling are well developed within the EU (as well as in other countries). Nevertheless several elements of the legal texts remain unclear and require further clarification. This holds - among other things - for the lack of a threshold for the contamination of non-GM seed with GM seed. To respect the 0.9% threshold for products to be GMO free, the threshold for seed must be lower than 0.9%; however, legally nothing has yet been arranged for this matter although this issue has been discussed for a number of years.

Appendix 2

Supply balances soybean and rapeseed, maize market projection

Table A2.1	Soybean balance (1,000 tonnes) EU-27, 2003/04-2006/07 (2003/04=EU15; 2004/05 en 2005/06=EU-25)			
	2003/04	**2004/05**	**2005/06**	**2006/07**
Beans				
Production	577	780	832	1,140
Import	15,270	15,310	14,050	15,050
Export	10	10	20	30
Use	15,837	16,080	14,862	16,160
Oil				
Production				
from EU-seed	99	156	166	228
from imported seed	2,749	3,062	2,810	3,010
Import	18	190	600	1,050
Export	782	490	320	670
Use	2,085	2,918	3,256	3,618
Soybean meal				
Production				
from EU-seed	431	616	657	901
from imported seed	11,914	12,095	11,100	11,890
Import	20,486	23,040	23,540	24,580
Export	1,875	510	625	570
Use	30,957	35,241	34,672	36,800

Source: European Commission (2007a).

Table A2.2	Maize market projections for the European Union, 2004-2008 (mn t)				
	2004	**2005**	**2006**	**2007**	**2008**
Usable production	53.1	47.7	44.4	53.9	59.4
of which EU-15	41.0	35.0	33.1	34.3	35.1
EU-10	12.1	12.7	11.3	11.5	11.6
EU-2				8.1	12.7
Consumption	46.2	49.3	50.8	58.1	60.1
of which food and industrial	8.4	8.1	7.9	8.7	8.5
of which feed	37.5	40.6	42.3	47.9	49.1
of which bioenergy	0.0	0.3	0.5	1.0	1.9
of which EU-15	37.7	41.3	42.3	38.9	40.1
EU-10	8.5	8.0	8.5	9.2	9.5
EU-2				10.5	10.5
Imports	2.1	2.5	5.1	4.0	3.0
Exports	1.7	2.0	2.1	2.1	2.1
Beginning stocks	12.2	19.5	18.4	15.0	12.7
Ending stocks	19.5	18.4	15.0	12.7	13.0

EU-10: Ten new Member States, EU-2: Bulgaria and Romania
Source: European Commission, 2007c.

Table A2.3	Supply balance rapeseed (1,000 tonnes) EU-27, 2003/04-2006/07 (2003/04=EU15; 2004/05 en 2005/06=EU-25)			
	2003/04	**2004/05**	**2005/06**	**2006/07**
Seed				
Production	9,479	15,320	15,400	16,100
Import	418	120	490	470
Export	138	190	220	70
Use	9,759	15,250	15,750	16,500
Oil				
Production				
from EU-seed	3,736	5,975	6,502	6,762
from imported seed	167	47	206	197
Import	35	52	420	660
Export	177	130	60	65
Use	3,762	5,944	7,068	7,554
Meal				
Production				
from EU-seed	5,231	8,426	8,978	9,338
from imported seed	234	66	284	272
Import		81	100	90
Export		64	41	58
Use		8,509	9,321	9,643

Source: European Commission, 2007a.

Appendix 3

Pipeline GM varieties soybean and maize

Table A3.1	Recent approvals and approaching commercialisation genetically modified soybean a)			
Approved (food and/or feed)	**MON 89788 (Roundup Ready R2; Monsanto)**	**A2704-12 (Liberty Link; Bayer CropScience)**	**DP356Ø43-5 (Pioneer Hi-Bred)**	**DP305423-1 (Pioneer Hi-Bred)**
	Herbicide tolerance	**Herbicide tolerance**	**Herbicide tolerance**	**High oleic**
US	2007	1998	2008	a)
EU	Under consideration. Favourable opinion EFSA 2008	2008d	Under consideration	Under consideration
Australia	2008	2004	No information a)	a)
Argentina	Under consideration	Under consideration	Under consideration	Under consideration b)
Brazil	a)	a)	a)	a)
Canada	2007	2000	a)	a)
China	2008	a)	a)	a)
Japan	2008	2003	a)	a)
Mexico	2008	2003	a)	a)
New Zealand	2008 c)	a)	a)	a)
South Africa	a)	2001	a)	a)

a) Note that it is not always clear in which countries applications for approval have been made. Thus 'no information' indicates that information was not found concerning whether an application for regulatory approval for the event had been filed in the country in question. Furthermore, the list of countries is not exhaustive; b) In Argentina, a soybean with a stacking of both DP356043-5 and DP305423-1 was also being examined; c) Indicated by American Soybean Association press release, but not confirmed on New Zealand's Environmental Risk Management Authority website (www.ermanz.govt.nz/) or other related regulatory sites in that country; d) Approved 08 September 2008 for import and use in food and feed (OJ L247, 16.9.2008).
Source: Various sources including EFSA website (www.efsa.europa.eu/ EFSA/ScientificPanels/GMO/efsa_locale-1178620753812_GMOApplications.htm), Argentinean CONABIO website (www.sagpya.mecon.gov.ar/new/0-0/programas/conabia/liberaciones_ogm_2007.php), agbios online GM database (www.agbios.com/dbase.php) and company websites.

Table A3.2	**Recent approvals and 'approaching commercialisation' genetically modified maize**
Approved (food and/or feed)	**MON 89034 (YieldGard VT Triple PRO; Monsanto)**
	Insect resistance
US	2008
EU	Under consideration
Argentina	Under consideration
Brazil	No information a)
Canada	2008
Colombia	2008
Japan	2008
Mexico	2008

a) Note that it is not always clear in which countries applications for approval have been made. Thus 'no information' indicates that information was not found concerning whether an application for regulatory approval for the event had been filed in the country in question. Furthermore, the list of countries is not exhaustive.

Source: Various sources including EFSA website (www.efsa.europa.eu/EFSA/ScientificPanels/GMO/efsa_locale-1178620753812_GMOApplications.htm), Argentinean CONABIO website (www.sagpya.mecon.gov.ar/new/0-0/programas/conabia/liberaciones_ogm_2007.php), agbios online GM database (www.agbios.com/dbase.php) and Monsanto website (www.monsanto.com)

Appendix 4

Impact assessment of an interruption of soybean imports into the EU

An impact assessment of an interruption of soybean imports into the EU due to the presence of unapproved GMOs has been calculated in the by DG-Agri (2007) commissioned study. Three possible scenarios were evaluated (DG-Agri, 2007: 5-11):

1. A minimal impact scenario, which concerns an interruption of US soybean/meal imports that would be fully substituted by imports from other exporting countries, i.e. Argentina and Brazil;
2. A medium impact scenario, which concerns an interruption of US and Argentinean soybean/meal imports that would be partially compensated by increased imports from Brazil. This would leave an import deficit of 9.9mn tonnes of soybean meal equivalent.[1]

- This scenario would lead to a price increase of around 60% and a lower consumption level of soybeans/meal by around 6%, while triggering demand for cereals. Combined, this will result in an expected rise in feed expenditure by 23%.
- Pig meat sector (short term → 2 years): imports would be slightly higher than in the baseline scenario, while exports would be marginally lower (1% after 2 years). The EU pig price would rise by around 10%.
- Poultry meat sector (short term → 2 years): EU output falling around 2% below baseline; more import, less export; fall in consumption by around 1%.
- Beef meat sector (short term → 2 years): Substitution effect: beef imports would increase by 13% and exports would fall significantly below baseline level. Beef consumption rises more than 1% above baseline as a result of higher price projected for pork and poultry.
- Medium term: EU meat production and consumption almost manage to recover after to baseline level by year 5. Import of pig and poultry remains above baseline; export below. Meat prices return close to baseline level.

3. A worst case scenario, which concerns an interruption of US, Argentinean and Brazilian soybean/meal imports, without any compensation from other

[1] Taking into account an assumed increase in the production and imports of rapeseed meal and sunflower meal, the net shortage of soybean meal equivalent would be reduced to 3.3mn tonnes (DG-Agri, 2007: 6).

exporting countries. This would leave an import deficit of 32.3mn tonnes in soybean meal equivalent.[1]

- This scenario would lead to a price increase of around 60% and a lower consumption level of soybeans/meal by around 50%, while triggering demand for cereals. Combined, this will result in a rise in feed expenditure by 600%.
- Pig meat sector (short term → 2 years): pork production would fall 29% (first year) and 35% (second year) below the baseline scenario. EU will become a net importer of pig meat; drop of consumption to 24% below baseline, with a slight recovery in the second year due to higher imports.
- Poultry meat sector (short term → 2 years): Production would drop to 29% below the baseline in first year; and by 44% in the second year. Imports grow significantly, EU exports disappear. Domestic consumption would drop with 16% (first year) and 26% (second year) below baseline level.
- Beef meat sector (short term → 2 years): Imports would exceed the baseline more than fourfold and exports would be reduced to zero. Demand for beef meat expands, triggering a sharp increase in the beef meat price.
- Medium term impact: Two year import interruption still weighs heavily on EU in year 5. Pig and poultry meat production would remain well below the baseline level (-13% and -17% respectively), while beef meat production would exceed the baseline level by 15% in order to compensate for the shortage in meat supply. Import of pig and poultry far above baseline level; exports far below. Meat prices will drop well below baseline levels, driven by the decline in feed costs due to the fall in feed demand.

[1] Taking into account an assumed increase in the production and imports of rapeseed meal and sunflower meal, the net shortage of soybean meal equivalent would be reduced to 25.7mn tonnes (DG-Agri, 2007: 6).

Figure A4.1 Results of the modeling approach DG-Agri study 2007

Impact on EU oilmeals balance (deviation from the baseline, %)

OILMEALS	MEDIUM 2009	MEDIUM 2010	WORST CASE 2009	WORST CASE 2010
Production	-5.0%	-4.9%	-18.0%	-17.6%
Import	-7.5%	-7.3%	-76.2%	-74.1%
Exports	0.0%	0.0%	0.0%	0.0%
Total Stocks	-12.6%	-1.5%	-68.5%	0.5%
Consumption	-6.1%	-6.6%	-48.2%	-51.1%
Feed expenditure*	22.8%	22.8%	2068.2%	682.9%

* Total feed expenditure (incl. cereals and oilseeds)

Impact on EU pig meat sector (deviation from the baseline, %)

PORK	MEDIUM 2009	MEDIUM 2010	WORST CASE 2009	WORST CASE 2010
Net Production	-0.9%	-1.8%	-29.3%	-34.7%
Import	28.6%	74.3%	637.0%	5461.0%
Exports	-0.3%	-1.1%	-86.0%	-85.3%
Consumption	-0.9%	-1.6%	-23.9%	-17.4%

Impact on EU poultry sector (deviation from the baseline, %)

POULTRY	MEDIUM 2009	MEDIUM 2010	WORST CASE 2009	WORST CASE 2010
Net Production	-1.7%	-2.6%	-29.2%	-43.9%
Import	6.6%	10.6%	92.5%	158.3%
Exports	-2.9%	-5.9%	-100.0%	-100.0%
Consumption	-1.0%	-1.5%	-15.7%	-26.3%

Impact on EU beef meat sector (deviation from the baseline, %)

BEEF	MEDIUM 2009	MEDIUM 2010	WORST CASE 2009	WORST CASE 2010
Net Production	0.0%	0.0%	-1.1%	-2.1%
Import	12.7%	14.0%	397.4%	295.8%
Exports	-41.2%	-95.1%	-100.0%	-100.0%
Consumption	1.2%	1.5%	30.2%	23.1%

Source: DG-Agri (2007), appendix, p. 11.

According to the DG-Agri (2007) study, there is a real possibility that the medium and worst-case scenarios could materialise. The likelihood of the three scenarios becoming reality depends on the extent to which the major supplier countries are willing and able to take account of the EU market in their GMO authorisation and production strategies. This in turn depends on the relevance of the EU as an export destination for the exporting countries in casu.

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