GM crops: Reaping the benefits, but not in Europe

Socio-economic impacts of agricultural biotechnology

EuropaBio™

The European Association for Bioindustries

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About this report

This report provides a comprehensive overview of the socio-economic impacts of the cultivation and trade of genetically modified (GM) crops, based on the latest available scientific publications. First a global overview is provided. The socio-economic impacts of GM cultivation in Europe are explored in the next part which takes into account both observed benefits (ex post analysis) as well as lost opportunities (ex ante analysis). Finally, trade and regulatory impacts on Europe are analysed in the last section.

1. INTRODUCTION

Biotech crops growing around the world

Since the first commercialisation of genetically modified crops in 1996, agricultural biotechnology has spread rapidly around the world. In 2010, 15.4 million farmers in 29 countries cultivated GM crops and experienced socio-economic and environmental benefits.

Addressing benefits and concerns

The reasons for farmers to choose biotech crops include higher productivity, such as yield increases of up to 30% on the same amount of land, and extra income. Significant environmental benefits have also been recorded, such as reduced pesticide application and reduced CO_2 emissions, and decreased soil erosion through the adoption of no-till practices. However, especially in Europe people still have concerns about the impact of GM crops. Apart from ethical, environmental and safety issues, some people raise socio-economic impacts, like access of the technology for poor farmers or questions about who really benefits.

? REGULATING SOCIO-ECONOMICS?

The importance of taking the socio-economic impacts of GMOs into account has been highlighted by various groups and risk managers. As part of the December 2008 Environment Council conclusions, the European Commission was asked to compile Member States' considerations on this issue. The Commission report was published in April 2011.

Concerning regulation, it should be noted that, in modern market economies, economic impacts are not usually reasons to restrict products, since any economic risk is borne by economic actors. In any market, only economically viable products are successful.

The Commission confirmed this when it said that *"socio-economic factors cannot be taken into account when approving GM crops. To be approved, they must simply be shown to be safe for human health and the environment".*[1]

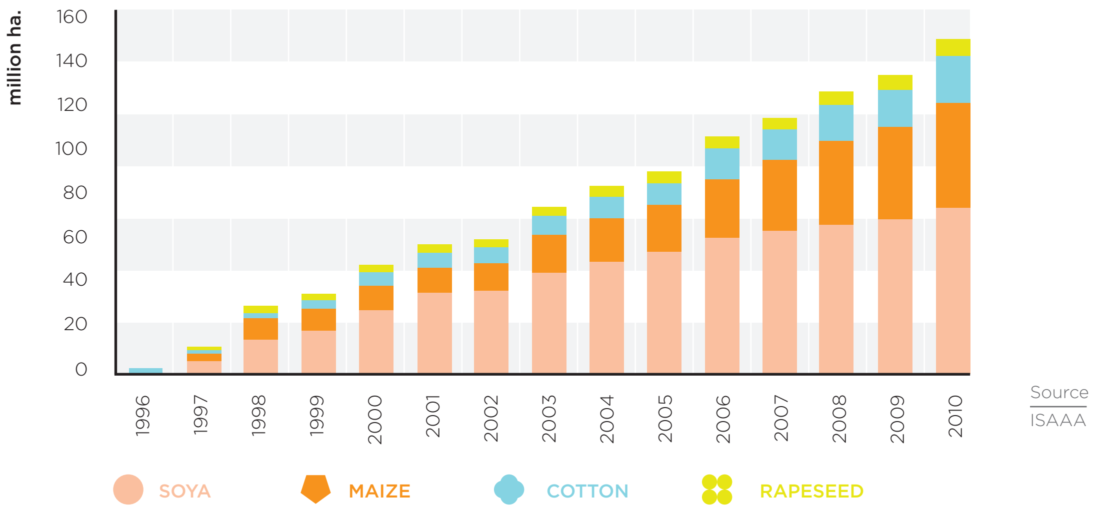
2. GLOBAL IMPACTS AT FARM LEVEL

? CAN 15 MILLION FARMERS BE WRONG?

"You're not going to spend money on a specific seed unless it has real benefits."
Paul Temple, UK farmer (2 March 2011, Brussels)

In countries where farmers are allowed to grow GM crops, they increasingly choose to do so. In 2010, 15.4 million farmers in 29 countries cultivated GM crops[2]. This is more than twice the number of farms in the EU. Most of these farmers stick to the technology once they have tried it themselves. 93% of Spanish farmers who grew GM maize in 2010 said they would do again in 2011. In 2010, GM crops were cultivated on 148 million hectares worldwide, which is roughly equivalent to the combined landmasses of France, Spain and Germany. It is more than the entire area of arable land in the EU[3].

Global cultivation of GM crops – by crop



Boosting farm income and production

"Biotech crops can increase productivity and (farmer) income significantly, and hence, can serve as an engine of rural economic growth that can contribute to the alleviation of poverty for the world's small and resource-poor farmers."[4]

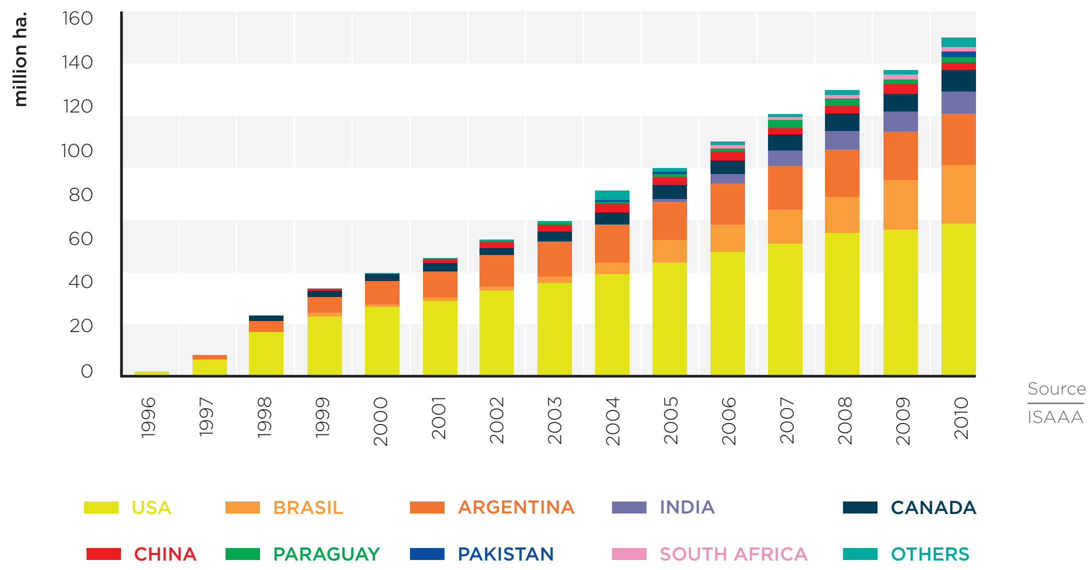
Independent research into the economic impacts of GM cultivation demonstrates clear benefits. The net global economic benefits at the farm level added by cultivating GM rather than conventional varieties have been estimated at $10.8 billion in 2009 – the equivalent of adding 5.8% to the value of global production of the four main crops of soya beans, maize, cotton and rapeseed. Combined benefits for a 14-year period (1996 to 2009) have been calculated at $64.7 billion[5].

GM crops have also made important contributions to increasing global production levels of the four main crops. To achieve the same level of production without the use of GMOs in 2009, an additional total area of 12.4 million hectares – equivalent to nearly the entire surface of England – would have been needed (including 5.6 million ha for maize and 3.8 million ha for soya beans)[5]. **The enormous uptake in GM crop cultivation can only be explained by the real and genuine advantages that these crops offer farmers.**

Average global income gains ($/ha) for 1996-2009 period for the four main crops[6]

SOYBEAN	MAIZE	COTTON	RAPESEED
42	22	26	39

Global cultivation of GM crops – by country
Global acreage with genetically modified crops by country, 1996-2010



Small farmers benefit too

Some say that only big farmers benefit from GM crops. Yet over 90%, or 14.4 million, of the farmers who grew GM crops in 2010 were small, resource-poor farmers in developing countries[7]. Farm size has not been a factor affecting their choice[8].

FAST FACTS

GMO cultivation worldwide and in the EU (2010)[9]

	World	EU
Number of farmers cultivating GM	15.4 million	(under) 6000
Number of countries with GM cultivation	29	8
Surface of GM fields	148 m ha	0.091 m ha
Change in surface of GM from 2009 to 2010	Up 10 %	Down 3.5 %
Total arable land	1.500 m ha	102 m ha

3. GLOBAL MACRO ECONOMIC IMPACTS

"Benefits from growing GM crops mainly derive from increased yields, which are greatest for small farmers in developing countries. Apart from higher yields, the adoption of GM crops can reduce production costs by reducing pesticide use, labour and fuel costs."[10]

Increasing food security

Higher productivity rates translate into higher food security in a world with continuing population growth and limited arable land. The additional production arising from GM crops between 1996 and 2007 has contributed enough energy (in kcal terms) to feed about 402 million people for one year, with additional production in 2007 alone contributing enough energy to feed 88 million[11].

Supporting development

The share of the farm income gains, both in 2009 and cumulatively (1996-2009), has been about 50% each for farmers in developing and developed countries[12]. The additional income derived from GM crops can enable more farmers to consistently meet their subsistence needs and to improve the standard of living of their households. Being able to afford more goods and services can have a positive 'knock on' effect on local, regional and national economies.

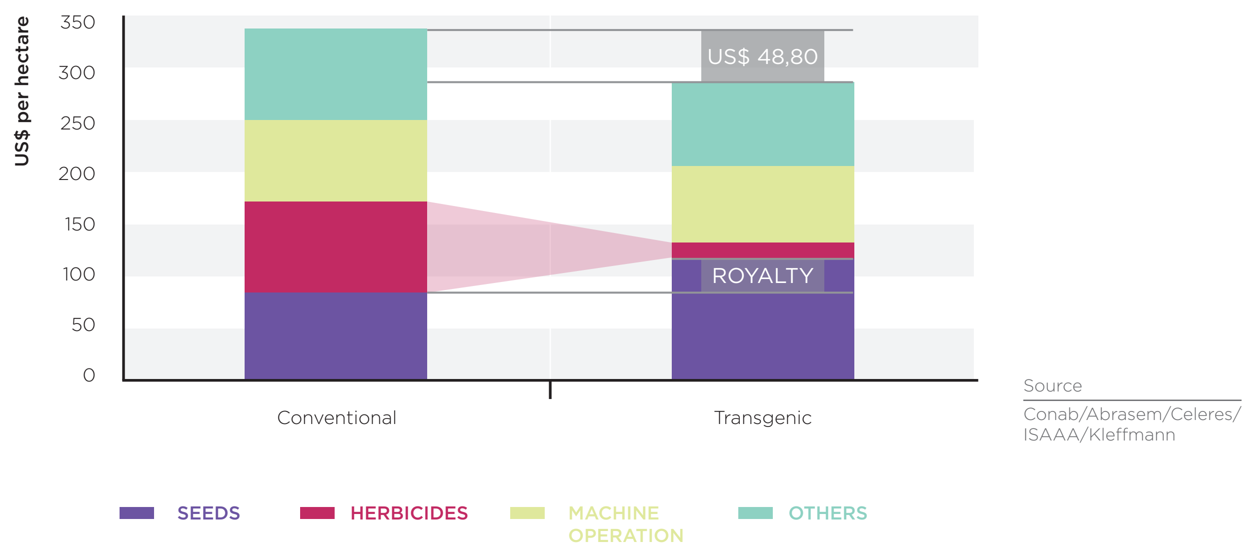
Commodity prices and distribution of benefits

World prices of maize, soybeans and rapeseed would probably be respectively +5.8%, +9.6%, and +3.8% higher than current levels if there were no GM crops[13]. Most GM crops go into feed, resulting also in consumer benefits from lower prices for meat. In Europe as in the rest of the world – two thirds of the benefits of growing GM are shared among European farmers and consumers, while on third goes to the gene developers and seed suppliers[14].

Patents and Royalties

Biotech companies invest very large sums in the development of the most useful new varieties. Just as with other technologies, this research is economically viable because the inventions can be patented. Farmers have the choice between high performance GM seeds that can be more expensive than conventional seeds because royalties are built into the price, or cheaper conventional seeds. Their choice will depend on their expected individual benefits.

Royalties as a cost component of transgenic crops
Cost comparison - Conventional & Biotech Soy (Brasil)
This graph shows why farmers in Brazil tend to choose biotech soy. Despite higher seed prices due to royalties, they eventually save $ 48.80 per hectare, mainly due to reduced herbicide input.



Market concentration?

Many GM seeds are being developed by multinational companies, though there is extensive ongoing research by SMEs and public universities. High R&D and regulatory costs and lead times constitute immense market entry barriers for smaller companies. A new advisory report to the Dutch government states that there are no indications whatsoever that market concentration is somehow inherent to GM technology[15].

In India, the introduction and widespread adoption of two Bt-cotton traits developed by multinational companies has opened the way to four Bt-cotton traits developed by Indian or Chinese companies.[16]

4. GLOBAL IMPACTS ON THE ENVIRONMENT

Less land use and better resource efficiency

Increasing yields by 6% - 30% on the same amount of land avoids the need to cultivate land that currently provides a haven for biodiversity or is used for conservation. GM crops with improved nitrogen-use efficiency need less fertiliser input. Less spraying and less need for fertiliser also means reductions in the use of tractor fuel and water. Soils are better protected from erosion and compaction through less ploughing, which helps conserve soil moisture. Field trials demonstrate that drought-tolerant crops can yield up to 20% more than their non-GM counterparts under the same growing conditions, enabling farmers to grow more while using less water.

Reduced CO_2 emissions

Less tillage or ploughing also helps to reduce CO_2 emissions. In 2009, the combined permanent and additional savings through sequestration due to the cultivation of GM crops was equivalent to a saving of 17.6 billion kg of CO_2 or removing 7.8 million cars from the road for one year[17]. By enabling farmers to grow more food, more reliably, in less predictable and harsher climatic conditions, GM crops can also contribute to climate change adaptation.

Less use of plant protection products

More efficient protection against insect damage results in a significant reduction in the need to spray crops. By 2009, the usage of GM crops had reduced pesticide spraying by 393 million kg of active ingredients, the equivalent of decreasing 17.1% of the global pesticide use[18]. There is a clear decrease in the amounts of plant protection products applied to GM crops[19], including a substantial 25-33% decrease in the use of agrochemicals for herbicide resistant crops[20]. While herbicide resistant weed populations may emerge, this is not a challenge specific to GM plants but applies equally for conventional agriculture. The adoption of herbicide tolerant plants led to a reduction in the toxicity of the herbicides used, and to a wider take up of no till farming, thereby limiting soil erosion, fuel use and CO_2 emissions.

Protecting biodiversity

Land use is probably the most important impact of agriculture on biodiversity. In general, biodiversity in fields is much lower than in untouched natural surroundings. This is inherent to the purpose of growing a certain type of crop and avoiding the presence of too many other organisms, such as weeds and pests, on the same field. The high performance of GM crops allows for intensive farming, meaning less land needs to grow the same amount of crops. Biodiversity on and around fields is a question of agricultural practices, not of crop technology. Numerous studies have demonstrated that GM crops have no adverse effects on non-target insects[21]. The reduction in crop biodiversity is linked to crop improvements in general, and not specifically to GM technology.

Almost all of today's agricultural crops and animals have been changed substantially in the history of mankind and have largely replaced their pre-agricultural ancestors. A recent literature review finds that, overall,

"currently commercialised GM crops have reduced the impacts of agriculture on biodiversity, through enhanced adoption of conservation tillage practices, reduction of insecticide use and use of more environmentally benign herbicides and increasing yields to alleviate pressure to convert additional land into agricultural use".[22]

FAST FACTS

EU research about GMO safety for health & the environment[23]

- Every GMO application independently assessed by EFSA
- €300 million EU funding for research into safety of GMOs over 25 years, over 500 independent research groups

No identified risk to human health or the environment.

5. EU IMPACTS FROM TWO AVAILABLE PRODUCTS

Two products approved for cultivation

GM crops can only be cultivated in Europe when they receive approval. To date, only two GM crop types have been approved for cultivation in the EU: insect-resistant maize and, since 2010, a potato for industrial use.

Agricultural Biotechnology in Europe Planting figures (in ha)

Country vs. Year	2006	2008	2010
Spain	53.667	79.269	76.575
Portugal	1.250	4.851	4.868
Czech Republic	1.290	8.380	4.830
Poland	100	3.000	3.000
Slovakia	300	1.900	1.248
Romania	90.000	9.000	822
Sweden	0	0	80
Germany	950	3.173	15
France	5000	0	0
Total	**152.557**	**109.573**	**91.438**

Source
ISAAA

Note: The strong decreases in France and Germany can be explained by political bans on MON810 maize.
Romania had to stop cultivation of GM soya bean when they joined the EU in January 2007.

Bt maize and the corn borer

For years, insect resistant GM maize was the only GM crop cultivated in Europe. In 2010, it was cultivated on 91,193 ha, representing over 99% of the land used for GM crop cultivation in the EU. This is the so-called Bt maize – a variant of maize which has been genetically altered to express a protein from the bacterium Bacillus thuringiensis. The Bt protein tackles the European corn borer, a widespread insect pest present in southern and middle Europe. The corn borer is capable of destroying up to 20% of a maize crop[24].

The Spanish Bt maize experience

Spain is the country with by far the largest GM cultivation in the EU, all of it being Bt maize. Additional farm income since introduction of the technology in Spain has been calculated at $93.5 million[25]. Average additional earnings in Spain were €186/ha[26]. The average yield increase is 6.3% and depends heavily on the intensity of pest infestation (with low infestation, yield increases of up to 1%, with high infestation, yield increases of 10 to 20% have been reported)[27].

In a recent survey, 93% of Spanish farmers who planted Bt maize in 2010 said they would do so in the next season[28]. In Spain, GM adoption is not statistically related to farm size[29] and there was no impact on the amount of farm labour employed. Yield gains on Bt maize translated directly into revenues increase, as there is no difference in the crop price paid to Bt or conventional maize farmers[30]. The economic welfare resulting from adoption of Bt maize in Spain is shared between farmers and seed companies, including the seed developer, seed producers and seed distributors. The largest share of welfare (74.4% on average) went to Bt maize farmers and the rest to the seed companies (25.6% on average)[31].

Bt maize and insecticides

A significant decrease in insecticide use was also demonstrated: fewer farmers applied insecticides on Bt maize (30% compared to 58% of conventional maize farmers) and those who sprayed did so much less frequently (0.32 treatments per year compared to 0.86 treatments by conventional maize farmers)[32].

Source
Europabio

Maize affected by corn borer

Impacts on non GM farmers, co-existence

Co-existence means that neighbouring farms, or perhaps even the same farm, grow both GM and non-GM crops. It is not a new concept, however. For decades, conventional agriculture has successfully co-existed with organic agriculture, and experience with co-existence between GM and non-GM agriculture shows that co-existence works. The European Commission has stated there have been no reports of any economic damages arising from difficulties with co-existence[33]. The Commission also published a new recommendation on guidelines for the development of national co-existence measures in 2010. For the rare cases where liability issues do ensue, national liability laws are applicable. Since only GM crops that have passed a rigorous authorisation procedure can be cultivated in the EU, coexistence measures do not concern environmental or health risks.

FAST FACTS

Bt maize in Europe:

- 91,193 ha of Bt maize in EU (2010)
- 6.3% extra crop yields on average
- Up to 20% extra crop yields when high level of corn borer infestation
- 12% to 21% more profits
- 186 €/ha extra income (EU average, 2007)
- €20.6 million overall direct increase in farm incomes EU-wide (2007)
- 2.25 to 4 million hectares of maize affected by corn borer

The Amflora Potato

Amflora is a genetically improved potato developed to produce a specific natural starch (amylopectin) tailored for industrial applications, such as paper, textiles and adhesives. Europe produces around two million metric tons of potato starch every year. The potato starch industry provides direct income to over 14,000 farmers and financially supports more than 4,000 employees' families. Factories are located in rural areas and play an important socio-economic role in their regions. Approved in 2010, Amflora was grown on 450 hectares in three countries for seed multiplication and initial commercial production. The main benefits of Amflora are that it:

- creates additional value for the starch potato farmers in Europe;
- reduces production costs;
- is a natural renewable resource;
- reduces the use of oil-based chemicals, energy and water.

6. LOST ECONOMIC OPPORTUNITIES IN THE EU

A (European) technology denied to most Europeans

In the second half of the 1980s, Van Montagu and Schell were the first to develop and test genetically engineered plants at the University of Ghent in Belgium. In 2010, cultivation in the EU was limited to two approved events, cultivated on 91,643 hectares in eight Member States. A large number of GM crops have been waiting for years for EU approval. Worse still for European farmers, GM cultivation of certain crops has been banned, though the bans are legally questionable, in Austria, Bulgaria, France, Germany, Greece, Hungary and Luxembourg.

A widening competitive disadvantage

Continued non-availability of the technology for EU farmers essentially leads to a competitive disadvantage compared to global competitors on world markets. As new seeds continue to come to market in other countries, but not the EU, this gap will widen.

Quantifying Europe's foregone benefits

European farmer margins would increase by an estimated €443 to €929 million each year, were they allowed to grow GM maize, cotton, soya bean, oilseed rape and sugar beet, where there is agronomic need[34]. Maize, oilseed rape and sugar beet have the highest potential. Europe is likely to lose out even more as new GM varieties are rapidly being planted by farmers in other parts of the world.

Revenue foregone by EU farmers, by crop and relevant countries

The table below shows possible benefits for different crops and countries, if the crops were allowed and cultivated where there is agronomic need and benefit.[35]

GM crop	Comments & background	Potential annual extra revenue in million €	Cultivation in EU in million ha[36]	Relevance for Member States
OILSEED RAPE	Herbicide tolerant GM oilseed rape represents 20% of world production. Net benefit €30 to €49/ha	195-318	nearly 9	Biggest (conventional) oilseed rape production in FR, DE, PL, UK, CZ
MAIZE	Insect-resistant GM maize currently grown on a limited area in the EU while maize pests are spreading further. In net increase in gross margin 86-106€/ha.	157-334	8.5	Maize cultivated in most Member States. Biggest surfaces affected by pests in FR, RO, DE, IT and HU[37]
SUGAR BEET	Savings from adoption of herbicide tolerant sugar beet are likely to be in the range €50-€150/ha.	73-219	1.46	Sugar beet cultivation in most Member States Biggest surfaces in DE, FR, UK, NL, IT, ES, CZ, AU.
COTTON	Bt cotton has been a very successful transgenic crop. Potential benefit to EU farmers of 50-150€/ha	20.8	0.26	Significant cotton production in Greece and Spain
SOYBEAN	Herbicide-tolerant GM soya bean grown in Romania before EU accession led to rapid yield increases per hectare. Expected GM soya bean input savings in EU: of 30€/ha	5-19	0.5	Soya beans cultivated in IT, RO, HU, FR, AU, SV, CZ
Total		**443-929 million €**		

Reduced Insecticide Use

Another of the benchmarks of the foregone environmental benefits is insecticide use. In 2007 France saved an estimated 8,800 litres of insecticides due to 22,000 ha of Bt maize[38]. Europe could save between 410 and 700 tons of insecticides if Bt maize were used to its full potential. The potential annual direct farm income benefit of Bt maize in the EU is estimated at between €160 million and €247 million[39].

Romania's Soy Story

Before its accession to the EU in 2007, Romania gained extensive experience with the cultivation of herbicide tolerant (HT) GM soya beans. These were grown commercially in Romania from 1999-2006 and accounted for 68% (about 137,000 ha) of all soya beans planted there in 2006. Cultivation then had to be stopped because the crop had not yet been approved for cultivation by the EU. Romania is still waiting for the authorisation of this GM soya bean which has been undergoing EFSA assessment since 2005.

Farmers who used HT GM soya beans indicated that it was the most profitable arable crop grown in Romania, with gains derived from higher yields and improved quality of seed coupled with lower costs of production. In 2006, the profit margin per hectare ranked between €100 and €187, while in the same year conventional soya bean growers were running losses. The increase in income was the result of herbicide cost reduction (on average, 1.9 treatments applied to HT soya beans versus 4.3 treatments to the conventional one) as well as the higher yields (3-3.5t/ha for HT versus 2 t/ha for the conventional product)[40]. In Romania, the average size of farms adopting GM HT soya beans was between 30 and 40 ha.

According to the Romanian agriculture minister Tabara, Romania's annual loss from not cultivating GM soybeans amounted to approximately €1 billion[41].

FAST FACTS

GM Soy in Romania[42]

- 31% higher yields (average)
- $175/ha average net increase in margin (over 8 years commercial use)
- $28.6 million annual extra farm income (2006)
- $92.7 million total extra farm income 1999-2006

7. IMPORTS, GM TRACES AND IMPACTS ON THE EUROPEAN CHAIN

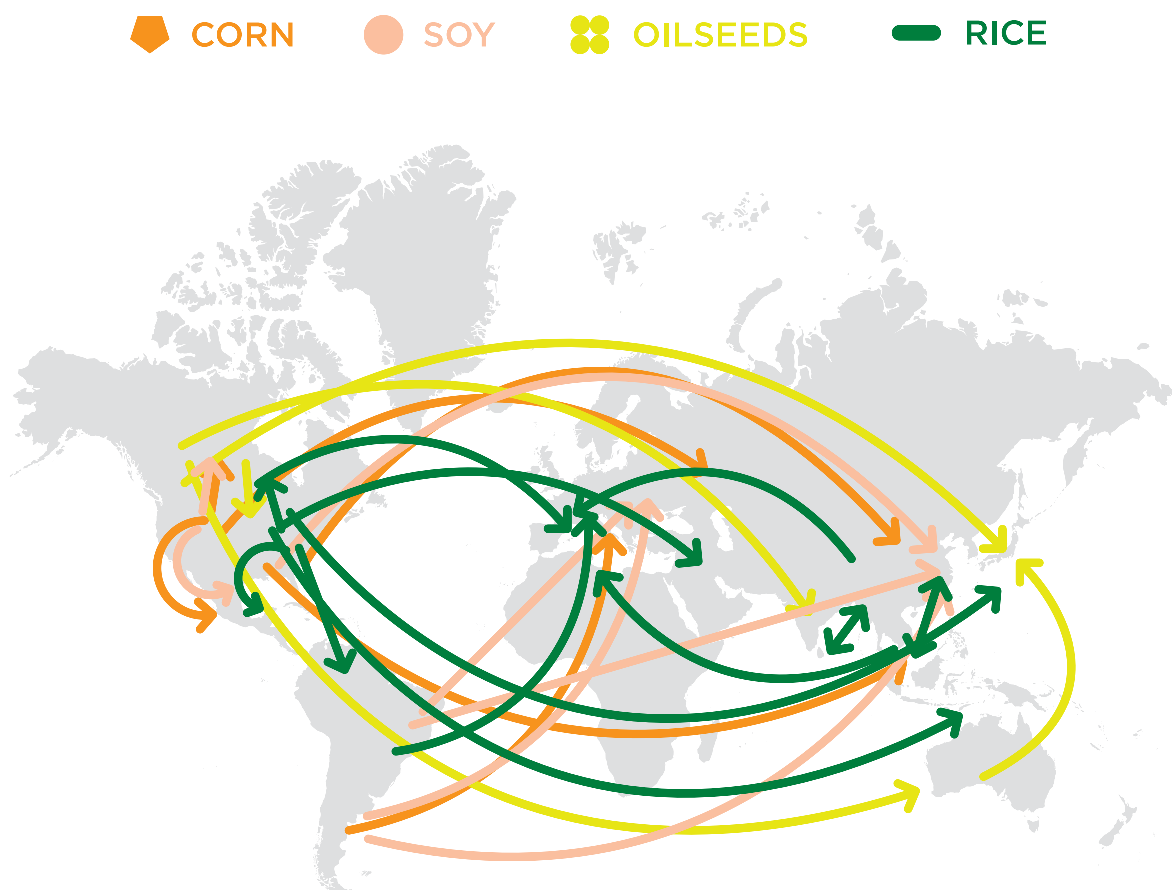
Asynchronous Approvals

The number of GM products available worldwide is growing rapidly. Other traits for maize and other GM crops (sugar beet, soya bean, rapeseed, potato and cotton) have been awaiting EU approval for many years and have meanwhile been approved and grown elsewhere in the world.

Outsourcing European agriculture

One of the main political objectives of the EU's common agricultural policy from its inception has been self sufficiency. A newer objective is competitiveness. As far as animal feed is concerned, the EU today is far from both objectives. The European Union imports significant quantities of grains (cereals and oilseeds) from third countries in order to meet European food and feed demand. Over 40 million tons of grain are imported per year from third countries, including 34.1 million tons of soymeal and 7.9 million tons of maize[43]. The EU's net imports are equivalent to outsourcing arable land almost as big as the entire area of Germany[44].

Trade flows of the four crops with significant volume of GM varieties



EU livestock farmers rely on GM imports

Europe has long had a zero-tolerance rule for residues of as yet unapproved GM varieties in non-GM imports. It has become almost impossible to import commodity grains from countries that widely use GM varieties. Blockage of soymeal from the EU's main suppliers as a result of traces of non-authorised GMOs would result in a soybean price increase of over 200% and could see farm profits drop by around €3 billion for the beef sector, €1.2bn for the dairy sector and €1bn for the pig meat sector. Despite possible gains for domestic feed producers, the overall cost to the economy of such disruptions could total €9.6 billion, according to a recent European Commission report[45]. A first step towards adapting the zero-tolerance policy to market realities is the introduction of a 0.1 % threshold for feed only, expected to enter into force in the 2nd half of 2011.

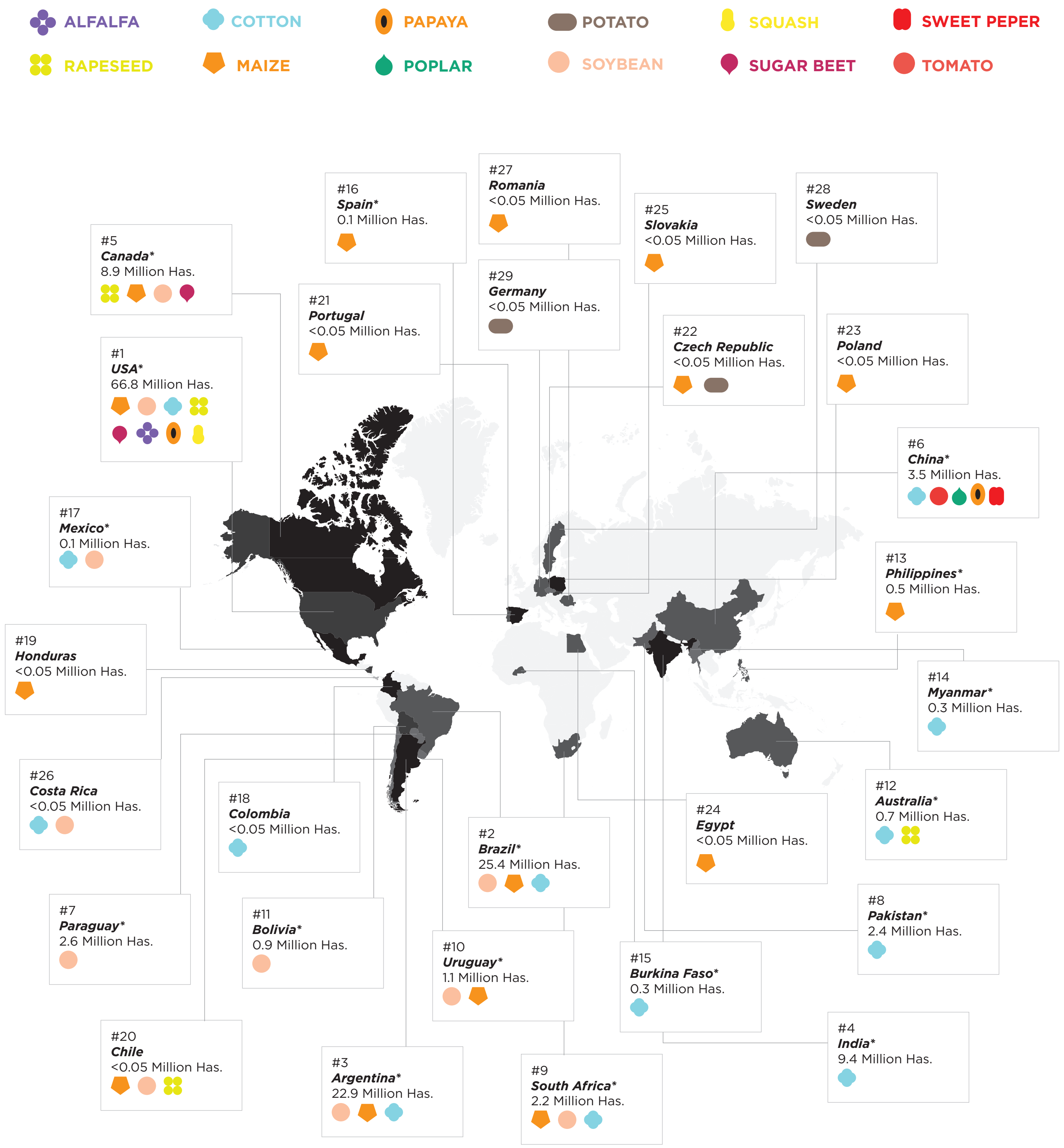
Concerns about cost of traces to EU supply chains

NGOs have repeatedly highlighted the costs of so-called GM 'contamination'. It is clear that there is a cost to ensuring co-existence in the supply chain. The decade-long experience of segregating organic from conventional supply chains suggests that these extra costs will be absorbed if there is a business case for them. It is also clear, though, that the cost of segregation depends more on the strictness of threshold levels allowed by public policy, rather than on the type of product being segregated.
A Commission report released in 2011 stated that the major suppliers of grain to the EU (operators in Brazil and US) are finding it increasingly economically unattractive but also physically difficult to separate different GM varieties in harvests and transport.

Europe's brain drain

Whilst the EU imports huge amounts of grain, it has been exporting scientific expertise in biotechnology. Because of the uncertain market prospects for agricultural biotechnology in Europe, many scientists and professionals from the EU find better employment in more technology-friendly environments in other parts of the world. Research on agricultural biotechnology started in Europe, but practical applications are now often developed elsewhere. Why cannot Europe turn the science into business opportunities?

Biotech Crop Countries and Mega-Countries, 2010



Source
Global Status of Commercialised GM/GM Crops, ISAAA, 2010

8. REGULATORY COSTS

The average cost for having GMOs approved in Europe has been estimated at €7-10 million[48] per event. These costs mainly accrue from the large number of studies which the applicant companies have to present to EFSA. The 30 approvals (including for imports) having been granted by April 2011 represent total costs to companies of between €210 and 300 million. This does not include the costs for the 73 GM products which were in different stages of the approval system in April 2011.

Indirect costs result from unpredictable timelines, which can take up to 13 years for GM cultivation applications and 47 months for import applications, as well as frequent, sometimes retroactive, changes in the requirements. For example, for dossiers submitted in 1998, EFSA was still asking new questions in 2011. With equally thorough requirements, yet swifter approvals in other parts of the world, and an increasing backlog in Europe, the result is an uneven playing field for companies. Some ideas to improve this situation are being discussed.

9. CONCLUSIONS

1. **Wherever they are allowed to, millions of farmers choose to cultivate GM crops. They derive socio-economic benefits from their use. If farmers did not get a suitable return, they would not continue to cultivate GM.**

2. **Higher productivity on the same amount of land is an important contribution to sustainable agriculture. Other large scale environmental benefits of GM crops have been proven and documented widely.**

3. **European farmers choose to cultivate GM crops where they are allowed to and where they benefit from their use. With EU cultivation limited mainly to Bt maize, it is clear that the main benefits are limited to regions most affected by the target pest, the European corn borer.**

4. **European farmers are missing economic opportunities worth between €443 to €929 million each year.**

5. **Europe is dependent on grain imports, most of which are GM. A slow approval process and trade barriers in Europe make imports of GM products more expensive and could result in major trade disruptions.**

6. **Many new crops are rapidly being developed and authorised around the world. According to the European Commission's Joint Research Centre, the number of commercial GM crops is set to increase to 120 or more by 2015. As new crops are released, which may include salt tolerant, drought tolerant, nitrogen efficient and nutritionally enhanced varieties, it seems unlikely that the EU can reasonably continue with its current approach.**

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