# Economical impact of the introduction of GMOs into the Hungarian Agriculture

*This study was prepared by ESSRG Kft. on commission from Green Capital Zrt.*

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Budapest, October 2008

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### *The state of the international agricultural biotechnology industry*

The state of the international agricultural biotechnology industry is extremely contradictory. On the one hand, according to the representatives of the industry, they experienced a two figure annual growth to reach a total of 114.3 million hectares on which genetically modified crops were grown in 23 countries around the world in 2007. On the other hand, more than a decade after their appearance, the majority (90%) of the area on which GM crops are grown is concentrated in five countries, all of which are located on the American continent (United States of America, Canada, Argentina, Brazil, and Paraguay). Only one country, the United States of America, is responsible for half of the world production of GM crops and for 70% together with Argentina.

In the year 2007, the market value of GM crops totalled 6.9 billion USD, which is 20% of the commercial seed market valued at 34 billion USD; 47% of the global GM market is made up by GM maize, 37% by GM soybean, and 13% by GM cotton. Taking into account the areas under cultivation, GM soybean is the leading grain crop and is grown on a total of 58.6 million ha (51% of the total GM grain crop), GM maize is grown on 35.2 million ha (31%), GM cotton on 15.0 million ha (13%), and GM rapeseed on 5.5 million ha (5%). Since the introduction of GM plants, resistance to herbicide has become the most widespread characteristic which is made use of in GM soybean, maize, rapeseed, cotton, and alfalfa and is grown on 63% (72.2 million ha) of the total cultivated area on which GM crops are grown. By the year 2007, the area on which GM crops that had more than one gene modification at the same time (21.8 million ha, 19%) exceeded that of GM varieties modified to be pesticide resistant (20.3 million ha, 18%). All the above also shows that the diversity of GM varieties is stagnating: only four plants (soybean, maize, cotton, and rapeseed) make up almost the whole of GM agriculture. The same situation is encountered when examining the genetically modified characteristics: herbicide resistance and pesticide resistance are the two characteristics that are relatively widespread in GM plants.

A wide range of organizational and structural changes took place in the industries affected by biotechnology as it appeared: the interweaving of industries, the forming of networks and alliances by newly established research and development enterprises with existing multinational companies, and the intensive international and concentration processes of the latter has decreased the number of large corporations playing a role in biotechnology to about half a dozen. Among the industrial sectors, the sectors of agriculture, pharmaceuticals, and the chemical industry must be emphasized, however the developments in agricultural biotechnology also include other bearings, such as the appearance of developments in the fields of energy providers (biofuels), environmental protection, and the plastic industry. The number of large corporations belonging to agricultural biotechnology has dwindled to five, and these have become known as the *Gene Giants*. They are Bayer, Dow Chemical, DuPont, Monsanto, and Syngenta. These companies are the largest of their kind in all the respective industry sectors and have combined market shares that vary between 23 and 100 per cent in these sectors.

The advantage of these agricultural biotechnology corporations makes it possible for them to receive an ever increasing portion of the profits arising from production. As a result of the possibility of setting prices in a monopolistic fashion, the beneficial advantages of free market competition do not manifest themselves; as an end result, the total societal subservience of the new technology is forced to dwindle. The number of employees that decreases through mergers and purchases has lowered the motivation of companies to conduct research and has led to a decrease in the ambitiousness of R+D as well. Competition in the whole of the seed and plant protection input markets has abated, and the increase in the few giant companies' "political size economics" has also significantly spread the effect made on state regulations.

### *The regulatory environment of the agricultural biotechnology industry*

The regulations of the United States is based on the approach that genetically modified organisms (GMOs) do not require any special treatment, new regulatory institutional system, or deviation from the usual food safety checks, since biotechnological products show a "substantial equivalence" with other new plants and foods, therefore the usual risk assessment approaches and techniques can be applied. This regulatory approach that does not require either labelling or special safety tests prior to introduction to the market gave a big boost to agricultural biotechnology development in the United States. In contrary to the United States, the regulations of the European Union require a uniform risk assessment of biotechnological products. The main principle of the regulatory system of the EU is the precautionary principle, which refrains from allowing even those biotechnological products to be commercially distributed in the case of which there is no proper scientific knowledge concerning the effects and the chance that the product can be harmful exists. The other major difference between the European and American approach to regulations is that in the EU, it is not only the product, but the production process is also taken into consideration, and since the process of producing biotechnological products is different from usual production processes, it inherently has different risks and uncertainties, for which regulations are necessary.

The EU and numerous other export markets have closed their doors to American genetically modified maize and soybean. Despite having conducted aggressive international politics for the sake of opening the markets to agricultural biotechnological products, the United States has achieved a Pyrrhic victory at most (for example, the 2006 WTO decision) and has led to mostly contradictory steps (for example, GM food aid to African countries). The import restrictions concerning GMO products are increasingly spreading from Australia and New Zealand to Japan and South Korea, including India and China. The Cartagena Protocol on Biosafety that became effective in 2003 is based on the precautionary principle, thus strengthening the international legitimacy of EU policies and also broadens the meaning of the definition of risk by including societal and economic risks.

### *The economic assessment of agricultural biotechnology in the supply chain*

If we wish to assess the products and services provided by agricultural biotechnology from an economic point of view, we must examine the performance they have provided thus far as well as their potential performance in all the steps of the food supply chain and in respect to all important parties concerned. The basic dilemma for farmers is the making of the selection of the type of seed and the related production technology. The offers of agricultural biotechnology companies compete with conventional seeds (hybrids), bioseeds, and local varieties (regional varieties) and their respective production processes. The success of GM crops is mainly influenced by their yield, the price of the seed, and the cost of providing protection against pests.

## Farmer experiences

The price of herbicide resistant GM soybean seeds results in a 15 EUR surplus cost to farmers, which is a 35% price premium compared to the price of conventional soybean seed. According to the most common estimate, the price premium in the case of Bt maize is 22 EUR/ha. The statement made by those in favour of agricultural biotechnology according to which GM crops reduce the need for plant protection products was found to be true for the first three years (1996-1998). However, the situation has changed since 1999 and the statement is no longer valid: the use of plant protection chemicals, and thus the pollution of the environment, is on the rise. Those ecological forecasts that predicted the relatively quick adaptation of weeds to the herbicide resistant biotechnology applications have proven to be true: in the case of the most widespread

Roundup Ready GM plants, the development of resistant weeds took place in three to four years, and from this point on, the "pesticide wheel" is once again set in its circular motion.

Regarding yield, the results in the case of Bt maize are promising: numerous studies show its advantages in yield compared conventional varieties. However, the yield comparisons in the case of GM and conventional crops depend upon the growing conditions, thus also including the regional characteristics of the production area, especially the prominence of pests and weeds. According to DG Agriculture, we are still lacking proof beyond a doubt regarding the fact of whether GM crops do indeed provide the farmer with a profit. On the basis of clearing costs per hectare, there is no significant difference between herbicide resistant soybean and its conventional partner; the cost effectiveness of Bt maize depends on the degree of European corn borer infestation; and there is also no clear conclusion in the case of herbicide resistant rapeseed regarding its economic profitability over its conventional counterparts. The most obvious and direct success of GM crops can be found in the combination of performance and degree of ease they provide: they guarantee a greater extent of flexibility in farming practice, since the amount of work they require is smaller; their ease resides in the increase in the productivity of work and the decrease in plant specific work costs.

Those farmers who are better integrated in the formal seed system and market are rather neutral to risk and tend to maximize average yields in their decisions concerning seed selection; thus, their approach to GM varieties is more open. Farmers who prefer local varieties and who are the in situ maintainers of planted biological diversity of plants and who are not part of the formal seed system and market but are more a part of the informal seed network are more negative towards GM crops.

Since Hungary is not involved in the commercial growing of GM plants, there is no experience regarding Hungarian farmers and the farming environment. A survey conducted among domestic farmers shows that they tend to be rather negative towards GMOs: they do not agree with the statement that a competitive drawback would arise from failing to produce GM crops; the possibility of having to apply a smaller amount of plant protection products is not a strong enough reason for their introduction; however, they do agree that their use should be avoided due to the lack of knowledge concerning the effects of their production. Ex ante economic assessments performed in Hungary do not provide particularly attractive or beneficial results in regard to the growing of GM crops, although the exogenous variables are optimistic concerning the development of conditions.

## The judgement of GMOs in the food industry

Commercial food retail plays a prominent role in the supply chain. By practically "blowing up" the preferences of consumers, the steps taken and decisions made by retail companies have a definitive effect both on food processors and seed producers, as well as farmers. Through the process of food supply chains becoming global, the strategic steps taken by European commercial food retailers will have effects that extend beyond the orders of Europe. The competition strategies of companies and commercial retailers in the food sector are increasingly based on building values attributed to high quality products and those that are affixed with brand names; an important strategy is the development and use of own brands ands labels. This competitive strategy also includes the companies having to take greater responsibility and undertaking greater risks in the maintaining of the quality of food products: the fears and worries of consumers regarding the safety of food products are unequivocally linked to the financial performance of companies and their position on the competitive market. European commercial food companies reacted to the appearance of first generation GM crops by voluntarily affixing their own brands with GM labels as a result of appreciating the resistance they met on behalf of consumers. A large portion of commercial retailers as well as the largest food producing companies took steps to

ensure that their supply chains guaranteed freedom from GM products and also documented these steps and communicated them to their consumers. In the case of the first generation GM crops, these companies clearly exerted pressure on farmers to refrain from using the related technological developments. In order to protect heir brand names, aspects of quality, reputations, and finally their competitiveness, the powerful players in the food supply chain attempt to avoid using any GM components in their supply chains.

A quarter of domestic food producers regard the appearance of derivatives produced from GM plants as an everyday task; within this sector, the participants of the animal products chain are the most affected. Concerning the approach of food producers, it is worth stressing that they hold themselves to be insufficiently prepared and domestic regulations to be insufficiently stringent. Due to the shortcomings felt in this latter field, the trust shown by consumers can be led to decrease, which results in deteriorated competitiveness. Views provided by food producers show that they feel the consumer demand for labelling is justified and generally support Hungary being declared a GM free zone.

On the basis of surveys, it can be established that on the level of the national economy, the maintenance of the GMO free national image is, at the worst, cautious (but causes no losses), and, in a better case, a winning strategy until the time consumers of the domestic and export markets of the given country have no more feelings of antipathy against GM products.

## Consumer judgement of GMOs

The history of agricultural biotechnology shows a tempestuous picture concerning consumers' acceptance. There are substantial differences between both the approach and the behaviour shown by consumers of various countries. The main conclusion of international and domestic consumer studies is that the majority of European and Hungarian consumers are disinclined to accept agricultural biotechnology. Domestic consumers are especially negative towards agricultural GM products even in a European comparison, and they also have strong negative associations linked to GM products. Consumers feel that the introduction of GM products is mostly spurred by business interests and they fail to see, or rather miss, those societal gains that are manifest on a wider scale. The orientation of values according to which GM crops include an undesirable intervention into nature and which sees the process as a vain attempt to gain unnatural control over nature is characteristic of unsympathetic consumers. According to studies, the majority of consumers would be willing to pay more for GM free products and foods than those that include GM ingredients. Several studies also show that it is not the knowledge or the lack of that is a good indication of the consumer's attitude toward GMOs, but rather the trust they show towards the institutional system of the food supply chain. According to the results of these studies, the degree and extent of trust displayed towards science, the regulating authorities, the business world, and non-governmental organisations (NGOs) holds a more important explanation in any given society. It is the failing and decrease of this trust in Europe, especially the lack of trust towards science, regulating authorities, and the business world, as well as the discredit these institutions have, that is the essence of the problem.

### *The effects of agricultural biotechnology on the level of the national economy*

The majority of analyses conducted on a macroeconomic level attempt to arrive at conclusions concerning the various economic relations of GM products from the point of view of expected changes to the common good and well being by utilizing abstract and theoretical models. When including the heterogeneity of consumers and farmers, and by assuming market failure to be endogenous, these models tend to show that the production of GM crops in those countries where consumers demand non-GM products leads to a decrease in well being. A further message the models have is that there is no optimal economic solution to the question of labelling (indicating

GM content), since the interests of various societal – economic groups vary on a large scale. Labelling is therefore decidedly a normative, political issue which is decided in the strife of interests of the various groups on the basis of their political influence.

Certain analyses conducted on a macro level also show that a relationship with the reordering of international competitiveness exists: for example, between the decrease of the international competitiveness of the United States on the soybean market and the spreading of GM soybean in North America, the benefits of which were at least in part reaped by Brazil, as its supply of GM-free soybean could be sold on a larger market in those importing countries that demand non-GM foods. Other studies also call attention to the fact that the production of certain GM crops could have outward radiating negative effects, such as the negative external effect of GM oilseed rape on conventional organic varieties as well as on honey producers. Thus, when economically evaluating agricultural biotechnology, agricultural policies must calculate with quite extensive economic effects, which influence the normal business conduct and well being of numerous players of the economic markets.

The growing of both GM and non-GM plants (coexistence) and the possibility of implementing the various types of agricultural practices is a very important question. In the case of growing non-GM maize sowing seed and GM maize sowing seed together, significant changes would have to be made to the agricultural practices presently used; the most important factor is to increase isolation distances/buffer zones to 400-600 m. However, adhering to the obligatory isolation distances does not have the same effects on farmers. The characteristics of the ownership of land in a given region substantially influence the economic viability of coexistence. Land divided into small plots and the prominence of numerous small family farms as opposed to large land owners (as the situation on Hungary is) all increase the price to be paid for coexistence and decrease its economic viability within a given region. This is especially true if ecological farming exists or can be considered to be widespread in the given region or if labelling and protecting the geographical source constitutes an important added market value.

The production of GM crops thus cannot be considered as merely a decision to be made freely by the growers themselves in as much as it has negative external effects. It infringes upon the freedom of neighbouring growers within the buffer zone to make their choice and upon their economic interests. The likelihood of cross pollination can cause damages within small economic frames to biological diversity that are difficult to handle both on the level of genetics and habitat. It is not clear what legislative frameworks should be used for the definition and management of all these potentially arising damages. Neither do present national coexistence regulations look beyond economic losses, nor does the Civil Code seem suitable for the assertion of damages sustained beyond the limited realm of property and commerce that take place in the natural environment and biological diversity.

Agricultural policies will always have to face serious economic and societal issues in case GM crops are put into production, since either decision will result in organic and traditional farming practices to be either upheld or to disappear. For example, experience in Aragon and Catalonia indicates that the organic farming of those plants that are also grown in a GM variant in the same region can be drastically reduced. This is a severe market loss to both the growers and to the consumers of organic products.

Considering the tendencies of demand on the present food market, it can be established that the present products offered by agricultural biotechnology, as opposed to organic products resulting from the various forms of ecological production, do not provide added values to consumers regarding either comfort or a healthy diet. Thus, in this respect the maintenance, and in fact the support, of organic farming, seems to be economically more rational in terms of agricultural policies than the support of biotechnology.

### *Agricultural policy proposals*

Experiences and proposals for Hungarian agricultural policy:

- On the basis of the experiences gained thus far, there is no evidence to indicate that the production of first generation GM crops improves the productivity or decreases the costs of farmers to result in increased competitiveness.

- The majority of consumers in both Europe and in Hungary is opposed to GM foods, does not whish to consume GM products, and expects GM products to be unequivocally labelled in order to guarantee customers the right to freely make their choice. The characteristics of the market demand do not make it economically feasible to avert to the production of GM crops or to support their growing.

- The tendencies exhibited by the food market indicate that comfortable, safe, and healthy foods are going to continue increasing market share. In the eyes of consumers, the GM products presently available do not meet these criteria and consumers do not feel that these benefits would be attained. In fact, they generally increase an uncomfortable feeling in consumers, decrease the trust that consumers have in foods and in the related institutional system, which can easily have a backward effect on the competitiveness of the agricultural sector in the form of food scandals.

- Consumers are not in need of more information concerning GM foods, but their trust should be increased regarding the safety of the food supply chain, the regulating authorities, and the creditability and legitimacy of the other players on the market.

- The freedom of choice of farmers might be upheld through the continued application of coexistence regulations. At the same time however, thorough and detailed regional evaluations are necessary to be able to assess economic feasibility next to technological sustainability. In the case of certain circumstances or characteristics, the production of GM crops in certain regions can lead to a decrease in the competitiveness of the agricultural sector by taking away the possibility of organic farming as well as the competitive strategy based on geographical labelling concerning source and protection.

- The application of biotechnology in agriculture transforms the agricultural ecosystem and can also manifest effects on numerous levels of biodiversity; these affects will not limit themselves to areas under agricultural cultivation, but will irreversibly influence even natural protection areas in a manner that cannot be anticipated beforehand. Agricultural ecosystems are important parts of European and Hungarian nature protection and serve as institutes for the protection of biological diversity. It is well known that the EU gained a significant environmental contribution with the accession of Hungary. A price can basically not be put on the economic value of this asset, although it also appears in several sectors besides agriculture (for example, tourism). The effects of agricultural biotechnology thus include these sectors and their values and result in consequences that cannot be scientifically foreseen – precaution is therefore very much substantiated.

- The application of biotechnology in agriculture can have an effect on agriculture that totally transforms its social characteristics and traditions. Its effects on ownership structures, market relationships, the use of certain regions and microregions, and biodiversity will all have effects on society by benefits and costs being distributed in different degrees between the various concerned groups. Agricultural policies therefore have to face issues of societal justice. This demands that all those involved in domestic agriculture participate in a democratic forum that includes a wide stratum of society and that concerns the future of sustainable agricultural practices.

# Non-Technical Summary

### *The state of the international agricultural biotechnology industry*

The state of the international agricultural biotechnology industry is extremely contradictory. On the one hand, according to the representatives of the industry, they experienced a two figure annual growth to reach a total of 114.3 million hectares on which genetically modified crops were grown in 23 countries around the world in 2007. On the other hand, more than a decade after their appearance, the majority (90%) of the area on which GM crops are grown is concentrated in five countries, all of which are located on the American continent (United States of America, Canada, Argentina, Brazil, and Paraguay). Only one country, the United States of America, is responsible for half of the world production of GM crops and for 70% together with Argentina.

In the year 2007, the market value of GM crops totalled 20% of the commercial seed market; 47% of the global GM market is made up by GM maize, 37% by GM soybean, and 13% by GM cotton. Taking into account the areas under cultivation, GM soybean is the leading grain crop and is grown on a total 51% of the total GM grain crop, GM maize is grown on 31%, GM cotton on 13%, and GM rapeseed on 5%. Since the introduction of GM plants, resistance to herbicide has become the most widespread characteristic which is made use of in GM soybean, maize, rapeseed, cotton, and alfalfa and is 63% of the total area on which GM crops are grown. By the year 2007, the area on which GM crops that had more than one gene modification at the same time (19%) exceeded that of GM varieties modified to be pesticide resistant (18%). All the above also shows that the diversity of GM varieties is stagnating: only four plants (soybean, maize, cotton, and rapeseed) make up almost the whole of GM agriculture. The same situation is encountered when examining the genetically modified characteristics: herbicide resistance and pesticide resistance are the two characteristics that are relatively widespread in GM plants.

A wide range of organizational and structural changes took place in the industries affected by biotechnology as it developed, which changes limited the number of competitive large agricultural biotechnology companies to about half a dozen. Among the industrial sectors, the sectors of agriculture, pharmaceuticals, and the chemical industry must be emphasized, however the developments in agricultural biotechnology also include other bearings, such as the appearance of developments in the fields of energy providers (biofuels), environmental protection, and the plastic industry. The number of large corporations belonging to agricultural biotechnology has dwindled to five: they are Bayer, Dow Chemical, DuPont, Monsanto, and Syngenta. These companies are the largest of their kind in all the respective industry sectors and have combined market shares that vary between 23 and 100 per cent in these sectors.

The advantage of these agricultural biotechnology corporations makes it possible for them to receive an ever increasing portion of the profits arising from production. The beneficial advantages of free market competition thus do not manifest themselves; as an end result, the total societal subservience of the new technology is forced to dwindle. The number of employees that decreases through mergers and purchases has lowered the motivation of companies to conduct research and has led to a decrease in the amount of money invested in R+D as well. Competition in the whole of the seed and plant protection markets has abated, and a few giant companies can exert great influence on state regulations.

### *International regulations concerning agricultural biotechnology*

The regulations of the United States is based on the approach that genetically modified organisms (GMOs) do not require any special treatment, new regulatory institutional system, or deviation from the usual food safety checks, since biotechnological products are the same as any other plants or foods. This regulatory approach that does not require either labelling or special safety

inspections prior to introduction to the market gave a big boost to agricultural biotechnology development in the United States. In contrary to the United States, the regulations of the European Union require a uniform risk assessment of biotechnological products. The main principle of the regulatory system of the EU is the precautionary principle, which refrains from allowing even those biotechnological products to be commercially distributed in the case of which there is no proper scientific knowledge concerning the effects and the chance that the product can be harmful exists. The other major difference between the European and American approach to regulations is that in the EU, it is not only the product, but the manufacturing process is also taken into consideration, and since the process of producing biotechnological products is different from usual production processes, it inherently has different risks and uncertainties, for which regulations are necessary.

The EU and numerous other export markets have closed their doors to American genetically modified maize and soybean. Though EU has openned up its market for several food and feed containing GMOs after the decision of the WTO, import restrictions concerning GM products are increasingly spreading from Australia and New Zealand to Japan and South Korea, including India and China.

### *The assessment of agricultural biotechnology in the food supply chain*

If we wish to assess the products and services provided by agricultural biotechnology from an economic point of view, we must examine the performance they have provided thus far as well as their potential performance in all the steps of the food supply chain and in respect to all important parties concerned. The basic dilemma for farmers is the making of the selection of the type of seed and the related production technology. The offers of agricultural biotechnology companies compete with conventional seeds (hybrids), bioseeds, and local varieties (regional varieties) and their respective production processes. The success of GM crops is influenced by their yield, the price of the seed, and the cost of providing protection against pests. The sowing seeds of GM plants are 10-30% more expensive than conventional seeds.

### Farmer experiences

The statement made by those in favour of agricultural biotechnology according to which GM crops reduce the need for plant protection products was found to be true for the first three years (1996-1998). However, the situation has changed since 1999 and the statement is no longer true: the use of plant protection chemicals, and thus the pollution of the environment, is on the rise. The ecological forecasts have been proven to be true: in the case of the most widespread GM plants, the development of resistant weeds takes place in three to four years, and from this point on, an increasing amount of pesticides have to be applied to the ever more resistant weeds, leading to an endless “pesticide wheel.” In the case of genetically modified Bt maize, numerous studies show its advantages in yield compared conventional varieties. However, the yield comparisons in the case of GM and conventional crops depend upon the growing conditions, thus also including the regional characteristics of the production area, especially the prominence of pests and weeds. We are still lacking proof beyond a doubt regarding the fact of whether GM crops do indeed provide the farmer with a profit. On the basis of clearing costs per hectare, there is no significant difference between GM soybean and its conventional partner; the cost effectiveness of GM maize depends on the degree of European corn borer infestation; and there is also no clear conclusion in the case of GM rapeseed regarding its economic profitability over its conventional counterparts. The most obvious and direct success of GM crops can be found in the fact that they guarantee a greater degree of flexibility in farming practice, as the work they need is smaller and more flexible.

Farmers planting local varieties who plant genetically variable plants on their farms and also grow their own sowing seeds by putting a part of the produced seed aside or exchange it with other fellow farmers, meaning they do not acquire seeds through commercial channels, are more opposed to GM plants than those farmers who purchase their seeds from seed distributing companies.

Since Hungary is not involved in the commercial growing of GM plants, there is no experience regarding Hungarian farmers and the farming environment. A survey conducted among domestic farmers shows that they tend to be rather negative towards GMOs: they do not agree with the statement that a competitive drawback would arise from failing to produce GM crops; the possibility of having to apply a smaller amount of plant protection products is not a strong enough reason for their introduction; however, they do agree that their use should be avoided due to the lack of knowledge concerning the effects of their production. Economic assessments performed in Hungary do not provide particularly attractive or beneficial results in regard to the growing of GM crops, even though the exogenous variables are optimistic concerning the development of conditions.

## Food industry experiences

Commercial food retail plays a prominent role in the supply chain. By practically "blowing up" the preferences of consumers, the steps taken and decisions made by retail companies have a definitive effect both on food processors and seed producers, as well as farmers. Through the process of food supply chains becoming global, the strategic steps taken by European commercial food retailers will have effects that extend beyond the orders of Europe. The competition strategies of companies and commercial retailers in the food sector are increasingly based on high quality products and those that are affixed with brand names; an important strategy is the development and use of own brands ands labels. This competitive strategy also includes the companies having to take greater responsibility and undertaking greater risks in the maintaining of the quality of food products: the fears and worries of consumers regarding the safety of food products are unequivocally linked to the financial performance of companies and their position on the competitive market. European commercial food companies reacted to the appearance of first generation GM crops by voluntarily affixing their own brands with GM labels as a result of appreciating the resistance they met on behalf of consumers. A large portion of commercial retailers as well as the largest food producing companies took steps to ensure that their supply chains guaranteed freedom from GM products and also documented these steps and communicated them to their consumers. In the case of the first generation GM crops, these companies exerted pressure on farmers to refrain from using the related technological developments. In order to protect heir brand names, aspects of quality, reputations, and finally their competitiveness, the powerful players in the food supply chain attempt to avoid using any GM components in their supply chains.

A quarter of domestic food producers regard the appearance of derivatives produced from GM plants as an everyday task; within this sector, the participants of the animal products chain are the most affected. Concerning the approach of food producers, it is worth stressing that they hold themselves to be insufficiently prepared and domestic regulations to be insufficiently stringent. Due to the shortcomings felt in this latter field, the trust shown by consumers can be led to decrease, which results in deteriorated competitiveness. Views provided by food producers show that they feel the consumer demand for labelling is justified and generally support Hungary being declared a GM free zone.

On the basis of surveys, it can be established that on the level of the national economy, the maintenance of the GM free national image is, at the worst, cautious (but causes no losses), and,

in a better case, a winning strategy until the time consumers of the domestic and export markets of the given country have no more feelings of antipathy against GM products.

## Consumer experiences

The history of agricultural biotechnology shows a tempestuous picture concerning consumers' acceptance. There are substantial differences between both the approach and the behaviour shown by consumers of various countries. The main conclusion of international and domestic consumer studies is that the majority of European and Hungarian consumers are disinclined to accept agricultural biotechnology. Domestic consumers are especially negative towards agricultural GM products even in a European comparison, and they also have strong negative associations linked to GM products. Consumers feel that the introduction of GM products is mostly spurred by business interests and they fail to see, or rather miss, those societal gains that are manifest on a wider scale. The orientation of values according to which GM crops include an undesirable intervention into nature and which sees the process as a vain attempt to gain unnatural control over nature is characteristic of unsympathetic consumers. According to studies, the majority of consumers would be willing to pay more for GM free foods than those that include GM ingredients. Several studies also show that it is not the knowledge or the lack of that is a good indication of the consumer's attitude toward GMOs, but rather the trust they show towards the institutional system of the food supply chain. According to the results of these studies, the degree and extent of trust displayed towards science, the regulating authorities, the business world, and non-governmental organisations (NGOs) holds a more important explanation in any given society. It is the failing and decrease of this trust in Europe, especially the lack of trust towards science, regulating authorities, and the business world, as well as the discredit these institutions have, that is the essence of the problem.

## Experiences on the level of the national economy

The majority of analyses conducted on a macroeconomic level indicate a decrease in the level of overall well being if the production of GM plants were to spread in those countries where consumers are opposed. A further message the models have is that there is no optimal economic solution to the question of labelling (indicating GM content), since the interests of various societal – economic groups vary on a large scale. Labelling is therefore decidedly a normative, political issue which is decided in the strife of interests of the various groups on the basis of their political influence.

Certain analyses conducted on a macro level also show that a relationship with the reordering of international competitiveness exists: for example, between the decrease of the international competitiveness of the United States on the soybean market and the spreading of GM soybean in North America, the benefits of which were at least in part reaped by Brazil, as its supply of GM-free soybean could be sold on a larger market in those importing countries that demand non-GM foods. Other studies also call attention to the fact that the production of certain GM crops could have outward radiating negative effects on other producers who wish to remain GM free as that grants them a market advantage but cannot do so as their plants are GM contaminated. Thus, when economically evaluating agricultural biotechnology, agricultural policies must calculate with quite extensive economic effects, which influence the normal business conduct and well being of numerous players of the economic markets.

The growing of both GM and non-GM plants (called coexistence) and the possibility of implementing the various types of agricultural practices is a very important question. In the case of growing non-GM maize seed and GM maize together, significant changes would have to be made to the agricultural practices presently used; the most important factor is to increase isolation distances to 400-600 m. However, adhering to the obligatory isolation distances does not have the

same effects on farmers. The characteristics of the ownership of land in a given region substantially influence the economic viability of coexistence. Land divided into small plots and the prominence of numerous small family farms as opposed to large land owners all increase the price to be paid for coexistence and decrease its economic viability within a given region. This is especially true if ecological farming exists or can be considered to be widespread in the given region or if labelling (indicating the local nature of the given food) and protecting the geographical source constitutes an important added market value.

The production of GM crops thus cannot be considered as merely a decision to be made freely by the growers themselves in as much as it has effects on other farmers and results in causing them to pay extra costs or in economic losses. For instance, it can infringe upon the free choice of neighbouring farmers and upon their economic interests, since a farmer planting GM crops makes it impossible for neighbours within the isolation distance/buffer zone to conduct organic farming. The likelihood of cross pollination can also cause damages in biological diversity that are difficult to measure. It is not clear what legislative frameworks should be used for the definition and management of all these potentially arising damages. Neither do present national coexistence regulations look beyond economic losses, nor does the Civil Code seem suitable for the assertion of damages sustained beyond the limited realm of property and commerce that take place in the natural environment and biological diversity.

Agricultural policies will always have to face serious economic and societal issues in case GM crops are put into production, since either decision will result in ecological and traditional growing practices to be either upheld or to disappear. For example, experience in Aragon and Catalonia indicates that the organic farming of those plants that are also grown in a GM variant in the same region can be drastically reduced. This is a severe market loss to both the growers and consumers of organic products. Considering the tendencies of demand on the present food market, it can be established that the present products offered by agricultural biotechnology, as opposed to organic products resulting from the various forms of organic farming, do not provide added values to consumers regarding either comfort or a healthy diet. Thus, in this respect the maintenance, and in fact the support, of organic farming, seems to be economically more rational in terms of agricultural policies than the support of biotechnology.

### *Agricultural policy proposals*

Experiences and proposals for Hungarian agricultural policy:

- On the basis of the experiences gained thus far, there is no evidence to indicate that the production of first generation GM crops improves the productivity or decreases the costs of farmers to result in increased competitiveness.

- The majority of consumers in both Europe and in Hungary is opposed to GM foods, does not whish to consume GM products, and expects GM products to be unequivocally labelled in order to guarantee customers the right to freely make their choice.

- The tendencies exhibited by the food market indicate that comfortable, safe, and healthy foods are going to continue increasing market share. In the eyes of consumers, the GM products presently available do not meet these criteria and consumers do not feel that these benefits would be attained. In fact, they generally increase an uncomfortable feeling in consumers, decrease the trust that consumers have in foods and in the related institutional system, which can easily have a backward effect on the competitiveness of the agricultural sector in the form of food scandals.

- Consumers are not in need of more information concerning GM foods, but their trust should be increased regarding the safety of the food supply chain, the regulating authorities, and the creditability and legitimacy of the other players on the market.

- The freedom of choice of farmers might be upheld through the continued application of coexistence regulations. At the same time however, thorough and detailed regional evaluations are necessary to be able to assess economic feasibility next to technological sustainability. In the case of certain circumstances or characteristics, the production of GM crops in certain regions can lead to a decrease in the competitiveness of the agricultural sector by taking away the possibility of organic farming as well as the competitive strategy based on geographical labelling concerning source and protection.

- The application of biotechnology in agriculture transforms the agricultural ecosystem and can also manifest effects on numerous levels of biodiversity; these affects will not limit themselves to areas under agricultural cultivation, but will irreversibly influence even natural protection areas in a manner that cannot be anticipated beforehand. Agricultural ecosystems are important parts of European and Hungarian nature protection and serve as institutes for the protection of biological diversity. It is well known that the EU gained a significant environmental contribution with the accession of Hungary. A price can basically not be put on the economic value of this asset, although it also appears in several sectors besides agriculture (for example, tourism). The effects of agricultural biotechnology thus include these sectors and their values and result in consequences that cannot be scientifically foreseen – precaution is therefore very much substantiated.

- The application of biotechnology in agriculture can have an effect on agriculture that totally transforms its social characteristics and traditions. Its effects on ownership structures, market relationships, the use of certain regions and microregions, and biodiversity will all have effects on society by benefits and costs being distributed in different degrees between the various concerned groups. Agricultural policies therefore have to face issues of societal justice. This demands that all those involved in domestic agriculture participate in a democratic forum that includes a wide stratum of society and that concerns the future of sustainable agricultural practices.

# 1. Introduction

Biotechnology holds great promise in our age in the areas of technological development and, through its application, in economy and society. However, it is also a promise that exceptionally divides the public opinion of the world and its countries. This study focuses on the agricultural applications of biotechnology, which is the most disputed area of these biotechnological uses. It seems that those for and against agricultural biotechnology are divided by strong opposition. What one party sees an advantage, the other feels is unfounded optimism or, in worse cases, merely misleading information and unequivocally deigns those to be damaging effects. The dispute concerning agricultural biotechnology is extremely polarized. The very terms applied to agricultural biotechnology applications reflect this polarization: some take up a neutral tone with the terms genetically engineered, genetically modified, or transgenic plants and foods, while others, especially opposing consumers, talk of genetically manipulated products. In campaigns against agricultural biotechnology, the term "Frankenfood" has been applied as if to stress the monstrous nature of these products. An especially characteristic of this dispute is that science itself is divided in assessing the desirability of agricultural biotechnology. The scientific debate is often just as polarized as the statements met with in the media and the campaigns aimed at winning over public opinion. This dispute has entered Hungary just as it has the other European nations and the international debate forums between several countries and groups of countries.

This study does not generally aim at giving either party the upper hand but undertakes to study agricultural biotechnology, and within that field, especially the economic considerations concerning first generation GM crops[1], on the basis of international and domestic scientific literature. We therefore do not discuss in detail either the biological and ecological or the health and food safety considerations of agricultural biotechnology. These are issues of at least the same importance as the economic questions and play a very important role in the way agricultural biotechnology is generally regarded and scientifically valued. It must be obvious that agriculture policy decisions regarding the application of agricultural biotechnology cannot be based solely on economic considerations and must also take into account with the same level of importance environment protection, science policy, and even ethical criteria. However, the economic potential and the evaluation of the feasibility of agricultural biotechnology also have to be taken into consideration besides these aspects.

The economic considerations are naturally also important because the parties to the dispute also argue over this topic. Supporters of agricultural biotechnology regularly reason that Hungarian agriculture will forsake its international competitiveness if it fails to join in the "biotechnological revolution." They expressly show the application of agricultural biotechnology as part of the "knowledge based society" so often used as a slogan in politics. The supporters of agricultural biotechnology also reason that the spreading of the technology would be beneficial for farmers, as it leads to a decrease in their production costs. To the consumer, the use of these products is basically neutral and it does not matter whether the food they eat is prepared from genetically modified plants or not, as this does not lead to any substantiated scientifically provable risks or hazards. It could be beneficial for the national economy if the large multinational companies that

[1] First generation GM plants were created with a focus in plant protection, meaning they are resistant to either some pest or to a herbicide or include both of these qualities. Some of these plants manufacture the toxins themselves, which aims at keeping the pests away (plant incorporated protectant, PIP). When creating second generation developments, care was also put into output characteristics, which are modifications that the consumer can sense: the product is different in its outward appearance, durability, or nutrient content. Plants that are adapted to bad agricultural conditions (for example, dry, cold, or salt resistance) belong to this group. Third generation genetically modified plants include les of a focus on agriculture and food to rather provide pharmaceutical utilization (plant made pharmaceutical, PMP) and other industrial products (plant made industrial product, PIMP).

rule the agricultural input markets would develop their agricultural biotechnology products by building upon Hungary's traditionally strong plant breeding knowledge base.

However, those opposed counter that economic benefits cannot be realized on the level of the farmers, at least not in the case of all farmers. Biotechnology holds no advantages for the small family based farming that is characteristic of Europe and Hungary and in fact leads to their suffering disadvantages in competitiveness. The delicate situation of farmers increases as they are set against the giant companies that reach monopolistic status on the input side; losing their freedom, they become sorts of "day labourers" of the companies. Consumers, especially in Europe, but also in numerous African and Asian countries as well, oppose foods that are produced with the use of agricultural biotechnology. Therefore, goes the countering of the opposing party, those agricultural export countries that cater to markets where the majority of consumers is opposed are better off from the point of view of competitiveness if they ban the application of agricultural biotechnology in their territories in order to maintain their "GM free" statues.

In this study, we thus undertake to weigh the pros and cons detailed above and which affect the economic impacts of agricultural biotechnology and to establish which side has the better justifications. The total contents of the study is based solely on scientific literature and contains no own or independent empirical economic work. We concentrated on reviewing the literature that deals with economic sciences and with a wider spectrum of social sciences as well as those relevant in terms of economy and economic policy. The review can obviously by no means be comprehensive. However, we did attempt to review all the most important economic, business, and social science publications that dealt with the debate on agricultural biotechnology. We also attempted to track down analyses and studies published or completed on commission by the respective agricultural policy organizations (for example, USDA, DG Agriculture). In this discussion, we also relied on non governmental organizations that participated in the debate by endeavouring to substantiate their viewpoints with a scientific approach (for example, ISAAA, FoE).

The structure of our study is as follows. In the first large chapter following the present introduction, which is in the second chapter, we introduce the situation of the international agricultural biotechnology sector with the aid of statistical data and sectoral analyses. The chapter also contains a very brief description of the regulatory environment surrounding agricultural biotechnology. We do not attempt to present in detail either the changes in the regulatory and legal background or its present situation. We merely undertake to provide a glimpse into the two utterly different regulatory philosophies and styles of the United States and Europe. Using the food supply chain as a basis, the third chapter gives an overview of those economic studies that assess the practical experiences of agricultural biotechnology. We naturally first review the farmer level analyses. We then proceed to focus on the strongest economic player in the supply chain, the commercial food retailer, and also discuss the unique dilemma of food exporting countries that rises from the expectations of their export markets. The study then includes the main conclusions drawn by consumer surveys. We also discuss in further detail any results of which we know about with Hungarian relevance. The fourth chapter summarizes on one hand those macroeconomic analyses that endeavour to model the expected results of agricultural biotechnology on the level of the national and world economy. On the other hand, we tried to provide an overview of the relatively small amount of literature that deals with the expected or known economic effects of coexistence (growing side by side). The study is naturally concluded with a chapter summarizing the main conclusions that attempts to clearly set forth both the questions and considerations that are to be taken into consideration by domestic agricultural polity.

# 2. The international state and legislative environment of the agricultural biotechnology industry

## *2.1. The international situation of the sector*

The first field experiments with genetically modified crops (hereinafter referred to as GM crops) were conducted in 1987 and the first commercially significant production commenced in 1996: genetically modified plants (maize, soybean, cotton, and potatoes) were grown on 2 million hectares in North America. In 1996, 23 genetically modified crops received permits to be commercially grown in the United States, 12 in Canada, and 7 in Japan. According to the representatives of the industry, they experienced a two figure annual growth to reach a total of 114.3 million hectares on which genetically modified crops were grown in 23 countries around the world in 2007 (in 12 developing countries and 11 developed countries – see Table 1). (Franks, 1999; James, 2007)

*Table 1. The total area on which GM crops are grown in 2007 (by country, million ha)*

| Ranking | Country | Area (m ha) | GM plants |
|---|---|---|---|
| 1 | United States | 57,7 | soybean, maize, cotton, rapeseed, squash, papaya, alfalfa |
| 2 | Argentina | 19,1 | soybean, maize, cotton |
| 3 | Brazil | 15,0 | soybean, cotton |
| 4 | Canada | 7,0 | rapeseed, maize, soybean |
| 5 | India | 6,2 | cotton |
| 6 | China | 3,8 | cotton, tomato, poplar, petunia, papaya, sweet pepper |
| 7 | Paraguay | 2,6 | soybean |
| 8 | South Africa | 1,8 | soybean, maize, cotton |
| 9 | Uruguay | 0,5 | soybean, maize |
| 10 | Philippines | 0,3 | maize |
| 11 | Australia | 0,1 | cotton |
| 12 | Spain | 0,1 | maize |
| 13 | Mexico | 0,1 | soybean, cotton |
| 14 | Columbia | <0,1 | cotton, carnation |
| 15 | Chile | <0,1 | rapeseed, maize, soybean |
| 16 | France | <0,1 | maize |
| 17 | Honduras | <0,1 | maize |
| 18 | Czech Republic | <0,1 | maize |
| 18 | Portugal | <0,1 | maize |
| 20 | Germany | <0,1 | maize |
| 21 | Slovakia | <0,1 | maize |
| 22 | Romania | <0,1 | maize |
| 23 | Poland | <0,1 | maize |

**Source: James (2007), pg. 5**

The United States presently continues to retain its leading position in the production of GM plants, as can be seen by the fact that it makes up half of the area used for the production of GM crops. Of the 12 million farmers growing GM crops in the year 2007, 11 million are conducting agricultural activities on small parcels in developing countries. The majority produces Bt cotton: 7.1 million in China and 3.8 million in India (James, 2007, pg. 5-6). In the year 2007, the market value of GM crops totalled 6.9 billion USD, which is 20% of the commercial seed market valued at 34 billion USD. 47% of the global GM market is made up by GM maize, 37% by GM soybean, and 13% by GM cotton – declare the data presented by the sector's international organization (ISAAA) (James, 2007, pg. 15).

Taking into account the areas under cultivation, GM soybean is the leading grain crop and is grown on a total of 58.6 million ha (51% of the total GM grain crop), GM maize is grown on 35.2 million ha (31%), GM cotton on 15.0 million ha (13%), and GM rapeseed on 5.5 million ha (5%). Since the introduction of GM plants, resistance to herbicide has become the most widespread

characteristic which is made use of in GM soybean, maize, rapeseed, cotton, and alfalfa these are grown on 63% (72.2 million ha) of the total cultivated area on which GM crops are grown. By the year 2007, the area on which GM crops that had more than one gene modification at the same time (21.8 million ha, 19%) exceeded that of GM varieties modified to be pesticide resistant (20.3 million ha, 18%) – summarizes the ISAAA in its most recent report about the present situation. (James 2007, pgs. 10-11) 10-11)

The state of the international agricultural biotechnology industry is rather contradictory. The data presented above which are taken from the sector's international organization and which is often referred to in related literature, present a very congenial picture. At the same time, the data can be interpreted in a different way, which method is also presented in some literature. According to this latter view, more than a decade after their appearance, the majority (90%) of the area on which GM crops are grown is concentrated in five countries, all of which are located on the American continent (United States of America, Canada, Argentina, Brazil, and Paraguay). Only one country, the United States of America, is responsible for half of the world production of GM crops and for 70% together with Argentina. Only four countries use more than 30% of their arable land for the production of GM crops (United States, Argentina, Paraguay, and Uruguay), while the land used for the production of these crops barely makes up 3% in the rest of the GM producing countries. The diversity of GM varieties is stagnating: only four plants (soybean, maize, cotton, and rapeseed) make up almost the whole of GM agriculture. The same situation is encountered when examining the genetically modified characteristics: herbicide resistance and pesticide resistance are the two characteristics that are relatively widespread in GM plants. The attribute of herbicide resistance characterizes 80% of GM crops (FoE, 2008).

It is of particular importance to note that a wide range of organizational and structural changes took place in the industries affected by biotechnology as it developed. Such is the interweaving of industries, the forming of networks and alliances by newly established research and development enterprises with existing multinational companies, and the intensive international and concentration processes of the latter has decreased the number of large corporations playing a role in biotechnology to about half a dozen. This process can be described by the following (Matolay, 2005):

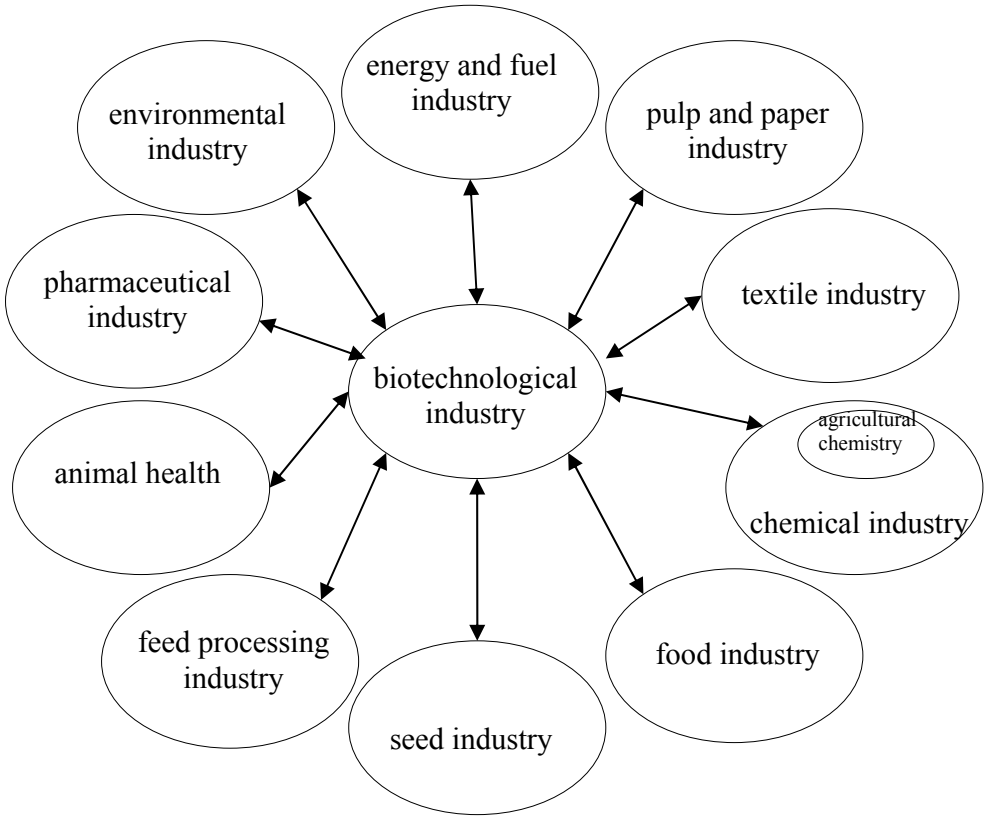
1. Horizontal integration: biotechnology, as a new technology affecting numerous industries, catalyses the harmonization of those industries.

2. Vertical integration: in order for the technology to become manifest in products, the players in the supply chain became linked through mergers and purchases.

3. Strategic alliances and networks: the innovative biotechnological companies utilizing the new technology and knowledge have induced cooperations within the biotechnological community that are connected by many strands.

Among the industrial sectors, the sectors of agriculture, pharmaceuticals, and the chemical industry must be emphasized, however the developments in agricultural biotechnology also include other bearings, such as the appearance of developments in the fields of energy providers (biofuels), environmental protection, and the plastic industry. On the basis of Giannakas and Fulton (2000), as well as Kalaitzandonakes and Hayenga (2000), the relationship between these sectors can be summarized in the following schematic figure (see Figure 1).

*Figure 1.* *The main industrial sectors affected by biotechnology*



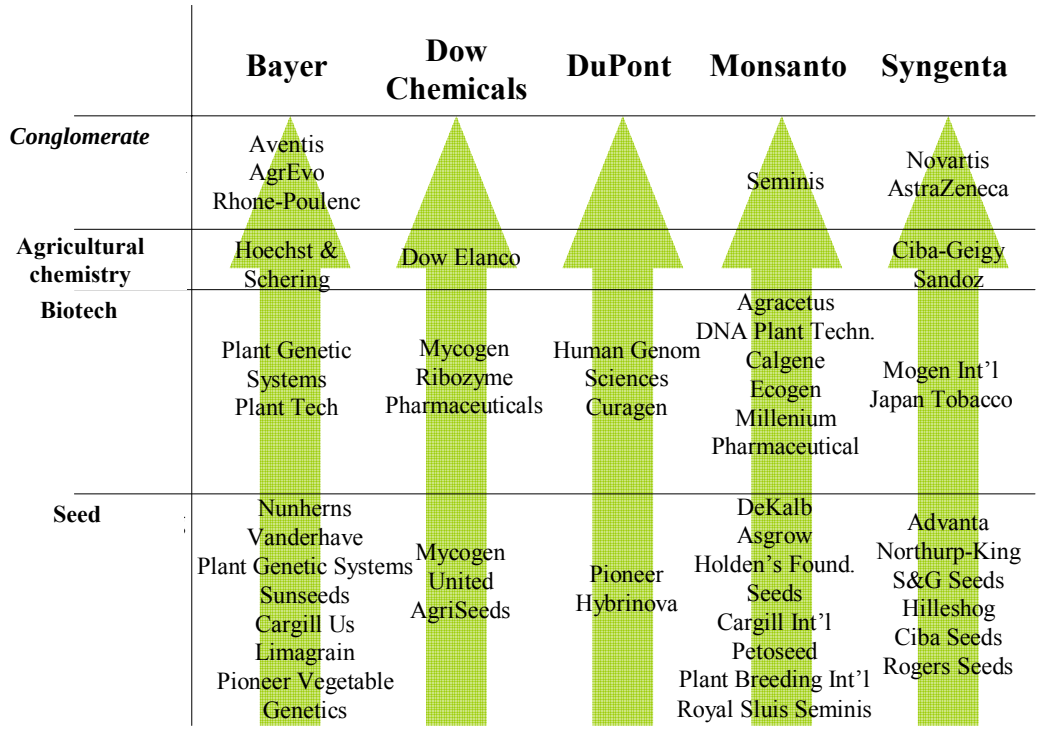

**Source: after Matolay (2005)**

The central position of biotechnology in the figure is substantiated by the fact that it endeavours to portray the effects biotechnology induces. The figure shows that the effects are not limited to a single sector or usage, but the consequences of biotechnology are borne by a large number of those. The arrows in the figure show not only effects, but in most cases also represent proprietary connections between the companies belonging to the given sectors. In the past decades, these proprietary relations have become much more complex along the lines of the three processes detailed above than as shown in the schematic figure. This is to be further substantiated by figures. However, it can already be clearly seen that the connections and through them, the companies transcend sectors and the main players are large diversified companies that operate strategically.

The bottom part of Figure 1, the seed, agricultural chemistry, and the pharmaceutical sectors, together with biotechnology, essentially shows the structure of the life science industry. The term that developed in the 1990's and which turned out to be short lived was at first used to refer to the connections based on the synergic effects of the sectors that were transforming as a result of biotechnology. The part of the figure referred to shows the ideal picture of the biotechnological companies of the time: an activity group integrated into one giant company or conglomerate. The purchases, mergers, and strategic alliances of the 1990's seemed to implement this concept, but around the year 2000 a process of splitting up commenced: the pharmaceutical and the agricultural directions diverged in the case of the majority of these large companies and continued operations as separate organizations.

The number of large corporations belonging to agricultural biotechnology has dwindled to five, and these have become known as the *Gene Giants*. They are Bayer, Dow Chemical, DuPont, Monsanto, and Syngenta. These companies are the largest of their kind in all the respective industry sectors and have combined market shares that vary between 23 and 100 per cent in these sectors. They possessed chemical, agricultural chemical, seed market, and biotechnological companies; besides subsidiaries, joint ventures and strategic alliances multiplied these connections. The following figure, Figure 2, shows which companies of the above mentioned sectors have become a part of the Gene Giants through concentration and integration processes.

*Figure 2* *Agricultural biotechnology concentration and integration purchases and mergers*




**Source: after ETC Group (2005); ERS (2004a, 2004b); Falcon–Fowler (2002); RAFI (1999)**

This process of purchasing and merging was generated on the one hand by the global trend of integration and concentration that took place in the given sector and generally in the global economy and, on the other hand, the attributes of biotechnology also contributed, such as the large degree of insecurity, the significant need for R+D investments, and the long time needed for development, licensing, and putting products on the market. Certain steps of the transformation process can be clearly distinguished (Matolay, 2005):

1. The stagnation that took place in the chemical industry in the 1980's led many companies to sell their chemical manufacturing sectors. This freed up capital which was used as a source for the company to enter into other business sectors. Consequently, companies either invested in R+D in the new sectors or purchased existing companies. The following corporate examples are very good illustrations of this process. The British chemical company International Chemical industries (ICI) separated its chemical branch under the same name and established a separate company by the name of Zeneca that focused on the manufacturing of pharmaceutical and plant protection products, seeds, and agricultural biotechnology. The American company Monsanto not only separated but also sold its chemical branch in order to be able to fully concentrate on biotechnology. DuPont sold its

oil business branch and purchased the largest player on the American seed market at the time, Pioneer Hi-Breed, in two instalments.

2. This same period also saw large chemical and pharmaceutical companies merge. For example, this is when the German companies Hoechst and Schering jointly established a corporation called AgrEvo for the manufacturing of agricultural and environmental protection products, to which Rhone-Poulenc also joined later on (following the purchase of two biotechnology companies and four seed production companies) to form Aventis.

3. The next step included the purchasing of seed companies: in this way, well integrated, supplemental products could be added to the plant protection products manufactured by chemical factories. This provided quick access to big stocks, to new varieties still under development, the capital and other instruments necessary for plant production measures, and the intellectual property and know how of smaller companies all at the same time. In only four years, between 1995 and 1998, close to 70 seed companies were purchased or integrated into joint corporations by small group of multinational companies.[2] At the same time, chemical companies also remained in the seed sector. (This is well illustrated by Table 2, dealing with seed producers.)

4. Utilizing the new biotechnological R+D activities in both the pharmaceutical industry and agriculture at the same time is a though that led to the birth of enormous life science conglomerates. The companies that were constantly joining forces hoped to achieve a technological and business synergic effect.

5. The majority of integrated companies has since then re-evaluated the life science strategy as an "evolutionary accident" (Thayer, 2001). The big corporations had barely formed and were already splitting and selling their seed production and plant protection branches.[3]As an explanation, they provided the following: (i) the absence of the expected R+D synergy; (ii) the incertitude of profits due to the mixed acceptance of genetically modified food by consumers and the possible suffering of the company's reputation; and (iii) that they are thus trying to avoid the possible negative reactions of regulating authorities and market protection organizations, since even in this way market concentration has become stronger than ever in the case of certain types of grain (King, 2000). That is how shortly after becoming associated, Monsanto and Upjohn split with Monsanto leaving behind its pharmaceutical activities but taking with it all its plant protection and seed production activities. That is how the newly incorporated Aventis split its agricultural branch and established Aventis Crop Science, which it quickly sold off. And that is how the buyer, the company Bayer, has become the only life sciences company, meaning it is the only company that integrates all four of the above mentioned areas into one corporation; however, Bayer does not use the life sciences "label" and has different names for the companies in the various sectors (for example: Bayer Crop Science).

[2] The most were purchased by Monsanto, which shocked the market by holding a purchasing "offensive" for barely eight weeks in 1998, as result of which the company, which until that time had not even been present on the seed production market, became the biggest seed producing company to become a prominent figure in every related sector.

[3] However, certain companies in the chemical industry rather took up an agricultural orientation and opted to back out of the concentrated pharmaceutical industry that necessitates large capital and R+D requisities.

*Table 2. The largest seed producing companies on the basis of their generated revenue (billion USD)*

| | 1983. | | 1989. | | 1998. | | 2003. | | 2006. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Royal Dutch/Shell (UK) | 0,65 | Pioneer Hi-Bred (USA) | 0,84 | DuPont (USA) | 1,84 | DuPont (USA) | 2,24 | Monsanto (USA) | 4,45 |
| 2. | Pioneer Hi-Bred (USA) | 0,56 | Sandoz (F) | 0,47 | Monsanto (USA) | 1,80 | Monsanto (USA) | 1,88 | DuPont (USA) | 2,78 |
| 3. | Sandoz (CH) | 0,32 | Asgrow (USA) | 0,27 | Novartis (CH) | 1,00 | Syngenta (CH) | 1,07 | Syngenta (CH) | 1,74 |
| 4. | Cardo (S) | 0,29 | Limagrain (F) | 0,27 | Groupe Limagrain (F) | 0,73 | KWS (D) | 0,53 | Groupe Limagrain (F) | 1,04 |
| 5. | DeKalb/Pfizer (D) | 0,19 | ICI (GB) | 0,25 | Savia S.A. de C.V. (Mex) | 0,43 | Seminis (USA) | 0,48 | Land O'Lakes (USA | 0,76 |
| 6. | Claeys-Luck (F) | 0,16 | Cargill (USA) | 0,24 | AstraZeneca (GB, NL) | 0,41 | Groupe Limagrain (F) | 0,48 | KWS (D) | 0,62 |
| 7. | Upjohn (USA) | 0,14 | DeKalb/Pfizer (D) | 0,21 | KWS (D) | 0,37 | Sakata (J) | 0,39 | Bayer Crop Science (D) | 0,43 |
| 8. | Limagrain (F) | 0,13 | SICA France Mais (F) | 0,17 | AgriBiotech (USA) | 0,37 | Delta & Pine Land (USA) | 0,32 | Takii (J) | 0,43 |
| 9. | Ciba-Geigy (CH) | 0,11 | Takii (J) | 0,17 | Sakata (J) | 0,35 | Bayer Cropscience (D) | 0,31 | Sakata (J) | 0,40 |
| 10. | Suiker Unie (NL) | 0.10 | Clause (F) | 0,16 | Takii (J) | 0,30 | Dow Agro Sciences (USA) | 0,20 | DLF-Trifolium (DK) | 0,35 |

**Source: after ETC Group (2005, 2007); ERS (2004a, 2004b); RAFI (1999)**

The arising questions regarding the effects of superiority on the market are justified due to the increasing concentration of the seed and plant protection sectors. Fernandez-Cornejo and Just (2007) attempted to research this topic. Basing their results on data provided by the USDA, they point out that half of the costs of soybean production and a third of the costs of maize production are made up of the input of seed and plant protection products (pg. 1269). The advantage of these agricultural biotechnology corporations makes it possible for them to receive an ever increasing portion of the profits arising from production. As a result of the possibility of setting prices in a monopolistic fashion, the beneficial advantages of free market competition do not manifest themselves; the monopolist is capable of claiming an increasing portion of the income from producers and consumers as its own; as an end result, the total societal subservience of the new technology is forced to dwindle. As a beneficial effect of the sectoral concentration, we could expect the increase in the quality of R+D (that is the relatively higher sums invested in R+D) to be considered a societal advantage due to the economic size of R+D. According to Schimmelpfennig et al (2004), they arrive at the contrary in their assessment: the number of employees that decreases through mergers and purchases has lowered the motivation of companies to conduct research and has led to a decrease in the ambitiousness of R+D as well (pg. 166). According to the results of the study presented by Fernandez-Cornejo and Just (2007), competition in the whole of the seed and plant protection input markets has abated, and the increase in the few giant companies' "political size economics" has also significantly spread the effect made on state regulations.

## *2.2. The international regulatory environment*

The United States is not only a world leader in agricultural biotechnology research and agricultural implementation, but was also the first to introduce regulations in this field. The comprehensive regulations of the United States (1986: Coordinated Framework for the Regulation of Biotechnology) divided authority between the American Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), and the federal United States Department of Agriculture (USDA), although the latter received the primary regulatory legal functions and the former two ended up having secondary, supporting roles (Zerbe, 2007). The regulations of the United States is based on the definitive approach that genetically modified organisms do not require any special treatment, new regulatory institutional system, or deviation from the usual food safety checks. This latter is based on the assumption that biotechnological products show a "substantial equivalence" with other new plants and foods, therefore the generally applied risk analysis approaches and techniques can be used in this case as well. This regulatory approach that does not require either labelling or special safety inspections prior to introduction to the market gave a big boost to agricultural biotechnology development in the United States (Falkner, 2007).

On the other hand, the European Union has, since the 1990's, taken a different approach to the regulation of biotechnology. Following Denmark's law on biological safety, the EU has given primary authority to environmental regulation (DG Environment) and secondarily to the Directorate General for Health and Consumer Affairs (DG SANCO) concerning the regulation of biotechnologically modified organisms. Contrarily to the United States, where there are no unified regulations concerning the checking of the safety of biotechnological products and the checks after having received the necessary permits is especially lax, the regulations of the EU require the unified risk analysis of biotechnological products. The main principle of the regulatory system of the EU is the precautionary principle, which refrains from allowing even those biotechnological products to be commercially distributed in the case of which there is no proper scientific knowledge concerning the effects and the chance that the product can be harmful exists, (Forsman, 2004). The precautionary principle is not accepted by the legislation of the United Sates as a legitimate principle, as those stress scientific certainty. The other major difference between the European and American regulatory approach is that the EU holds not only the product itself, but also the production process to be important. This means that the regulation is based on the fact that since the production process of biotechnological products differs from that

of conventional production processes, the former are in need of specially fitted regulations. The varying production process results in varying risks and uncertainties, which makes a different approach to the regulatory approach definitely substantiated. The EU has also created comprehensive labelling regulations concerning GMO products. The United States has no corresponding regulation. The following table aims at presenting the principle differences between American and European regulation.

*Table 3. The regulation of agricultural biotechnology in the United States and the EU*

| | **United States** | **European Union** |
|---|---|---|
| Regulating Authority | the **USDA** as the primary and the FDA as the secondary authority | the **DG Environment** is the leading regulating authority |
| Regulating principle | **Substantial equivalence:** the same regulations apply to GM foods and traditional foods; if there is no scientific proof concerning any danger, there is no need for separate regulation | **Precautionary principle:** a new regulatory framework is necessary due to the unknown risks and uncertainties; the lack of scientific proof concerning danger in itself does not mean regulation is unnecessary |
| The basis for the regulation | **Product based:** there is no differentiation between products based on the production process | **Process based:** the varying production processes require varying regulation for the resulting products |

**Source: Zerbe (2007), pg. 413**

Other historical factors have also contributed to the differences between the United States and the EU that has evolved. Numerous writers have studied the American social history of biotechnology and have pointed out that the Asilomar conference held in 1975 led the American regulations of biotechnology on its defining road. According to Sheldon Krimsky, a famous American studier of risk assessment, the influencing of the regulatory environment of biotechnology has unequivocally been passed into the hands of or has remained in the hands of those who have the most to gain professionally from this technology (Krimsky, 1982). The detailed historical analysis performed by Susan Wright also stresses that a reductionist viewpoint has taken power that has narrowed the meaning of risk to a technical approach and which has developed and strengthened the large influence a given segment of scientific researchers has on politics (Wright, 1994). Abels (2005) states that Asilomar has institutionalized an elitist process ruled by professionals in which a reductionist and positivist scientific viewpoint has achieved a monopolistic status in the forming of political regulation. The history of EU regulation is in sharp contrast. While the legacy of Asilomar is a regulatory environment that builds upon the legitimizing role of unfailing scientific knowledge and ruling out the interference of a society deemed as being ignorant as well as trusting in the self regulation of professionals and professional knowledge, the "popular political style of Brussels" is characterized by a more complex "science and society" approach to biotechnology. Due to the varying degrees of power held by those involved, the process of regulation in Europe is much more democratic and participatory than its American counterpart. Citizens and their organizations were given a larger degree of influence in the European institutional system than what was and is possible in the United States concerning biotechnology. Both the perception and definition of risk is more plural and comprehensive in the European regulatory environment, since they also give voice to the socio-economic aspect as opposed to a solely technical approach. Ables (2005) summarizes the main variations between the two political styles in the following table.

*Table 4. The political styles of Asilomar and Brussels*

| | **Asilomar** | **Brussels** |
|---|---|---|
| *The source of legitimacy* | scientific knowledge | democratic process |
| *Regulator* | self regulating | legal-political regulation |
| *Risk perception* | technical | social-economic |
| *The role played by citizens* | audience | participant |
| *The relationship between science and society* | knowledge | trust |

**Source: Abels (2005), pg. 346**

As a result of the more permissive and laxer regulatory environment, it is not surprising that the large corporations of the United States (Monsanto, DuPont, and Dow Chemicals) gained market dominance in the field of agricultural biotechnology. At the same time, their gaining of global market dominance was hindered and is still hindered by the opposition of the European market, which is based primarily on the opposition of the majority of European consumers towards genetically modified foods (see Chapter 3.3 for details). Even the first commercial shipment containing genetically modified plants sparked enormous opposition and anti-GMO campaigns in Europe. The standpoint of the majority of European consumers has since remained negative. The opposition of the market has in fact spread beyond the borders of Europe into numerous Asian, African, and Latin American countries. This has caused an enormous market obstacle for the further gaining of markets by the se large American agricultural biotechnology corporations, which actually undermines the potential for growth, future profitability, and investment appeal of the whole agricultural biotechnology sector (Falkner, 2007; Zerbe, 2007). It is of no surprise then that the price of shares of a leading American agricultural biotechnology company dropped by 25% in 1999 (Prakash–Kollman, 2003, pg. 632) and by 50% in 2002 in line with a serious drop in the sales of its products (Herrick, 2008, pg. 55-56).

The de facto moratorium imposed by the EU led to the collapse of the maize and soybean export bound to the EU from the United States. Annual American maize export dropped from 211 million dollars in 1997 to 200 thousand dollars in 2005. The export of American soybean also experienced a similar drop: in 1997 the annual figure of 2.3 billion dollars was a characteristic figure for the year, but it dropped to 511 million dollars by 2005 (Zerbe, 2007, pg. 415). Due to the deprival of the European export markets, the loss suffered by American farmers is estimated to be 300 million dollars annually (Falkner, 2007, pg. 104). The EU and numerous other export markets have closed their doors to American genetically modified maize and soybean. Despite having conducted aggressive international politics for the sake of opening the markets to agricultural biotechnological products, the United States has achieved a Pyrrhic victory at most (for example, the 2006 WTO decision) and has led to mostly contradictory steps (for example, GM food aid to African countries, see Zerbe, 2004; Herrick, 2008). The import restrictions concerning GMO products are increasingly spreading from Australia and New Zealand to Japan and South Korea, including India and China. By the end of the 1990's, it had become clear that the agricultural biotechnology sector had lost its PR channel in Europe and the main result of the aggressive politics conducted by the United States was that South American countries, and especially developing countries, feel that agricultural biotechnology is a technology forced upon them by North America and especially by the United States (Falkner, 2007, pg. 106).

Another result of the aggressive offensive politics of the United States was that it was left out of relevant events of multilateral environmental diplomacy, such as the Convention on Biological Diversity (CBD) and the Cartagena Protocol. The Cartagena Protocol on Biosafety, which came into effect in 2003, is based on the precautionary principle. It recognizes that a lack of scientific proof concerning a lack of danger does not mean a total lack of risk. The Protocol thus strengthens the international legitimacy of EU politics (Falkner, 2000). It also extends the definition of risk to include socio-economic risks, which is a particularly important step in the development of the increase of GMO regulations of developing countries. It also enables participant countries to establish through the application of their own GMO regulations certain requirements toward countries wishing to export products into their country. An example is the obligation to divulge information. The WTO's SPS agreement and the Cartagena Protocol are in direct contradiction with each other and make the issue of the further development of international agricultural biotechnology regulations an important question (Falkner, 2007; Zerbe, 2007).

The analyses found in literature on the topic (Bernauer–Meins, 2003; Prakash–Kollman, 2003; Falkner, 2007; Zerbe, 2007) all call attention to the fact that the deviations between the regulations of the EU and the United States can be attributed to the various national political economic environment. This refers to those societal-economic groups that aim at influencing the political agenda of agricultural biotechnology, the distribution of power that these groups have in relation to each other, how these groups managed to arrive at the standpoints they have, what issues they have linked together, and what relations they have established with the regulating authorities (Prakash–Kollman, 2003, pg. 627).

Public opinion is a very important factor in the differences in the regulatory environment. Society's perception of agricultural biotechnology shows significant differences in North American and in European public opinion. Survey all indicate that Europeans are a lot less in favour of and accept to a lesser degree the developments of agricultural biotechnology and its products than North Americans. An important source of the distrust and opposition of European consumers is the many food safety crises that have affected the European society in past years (from Belgian dioxin poisoning and British BSE to the appearance of foot and mouth disease and the fear caused by avian influenza). Another important difference between the two regions is the fact that during the time of developing the regulations, there were substantial differences between the economic significance and potential. Referring to an Ernst and Young survey of 1997-98, Prakash-Kollman (2003) pointed out that while companies belonging to this sector achieved incomes of 18.6 billion dollars, invested 9.9 billion dollars in R+D, and employed 153,000 people in the United States at the time, the same data in Europe for the time are only 3.1 billion dollars, 2.2 billion dollars, and 39,000 people (pg. 627). For this reason, the biotechnology sector represented a weaker lobby in Europe. The structure of the agriculture economy of the two regions is also very different. While the agriculture sector of the United States is becoming increasingly concentrated and industrialized, and has founded its international competitiveness on exporting cheaply as a result of mass production, Europe has knowingly protected the system of family farming in agriculture from the consequences of the price reducing world economic competition. In European agriculture, which is a lot less concentrated than its American counterpart, the plots of land cultivated by family owned farms have also become increasingly important in the protection of biological diversity. The spreading ecological agricultural practices also helped in the protection of biodiversity and were backed by knowing support politics of the EU and the various Member States. On the other hand, in the United States, where enormous plots of land were set aside for the purpose of environmental protection, agriculture never became an important player in the protection of biodiversity (Prakash–Kollman, 2003).

To summarize the international political economic situation, it is worth quoting the conclusions drawn by certain writers concerning the present situation.

> "In the case of biotechnology, it seems the principles of transparency and consumer sovereignty are rising above the influence of American multinational corporations and the governments that support them." (Prakash–Kollman, 2003, pg. 637)

> "The plants and foods produced with biotechnology continue soldiering in the world, but their future is defined at least as much by cultural values and societal preferences as by technological aspects." (…) As the biotechnology industry cannot win over consumers to GM foods, neither will the power of the United States be able to." (Falkner, 2007, pg. 108)

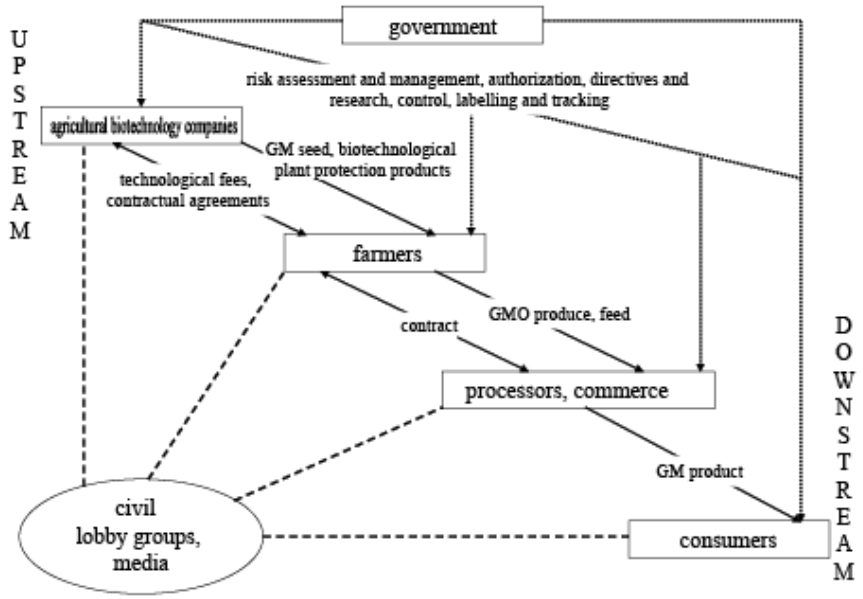
> "Both the United States and the EU are searching for available scientific proof to substantiate their viewpoints and to discredit the others viewpoint. However, these statements are not sufficient to handle the complexity of the problem and the diversity of the situations of all those involved in this dispute. Standpoints based on solely those facts that can be scientifically proven fail to take into account those issues that should receive an important role in the development of regulation: Who decides what the risks are? On what basis? What trade-offs does a given regulatory system carry with it? These questions concerning agricultural biotechnology are inescapably normative." (Zerbe 2007), pg. 420)

# 3. The evaluation of agricultural biotechnology in the food supply chain

If we wish to assess the products and services provided by agricultural biotechnology from an economic point of view, we must rightly examine the performance they have provided thus far as well as their potential performance in all the steps of the food supply chain and in respect to all important parties concerned (see Figure 1). Our evaluation obviously commences at the level of the farmers, who are the purchasers of the products and services provided by agricultural biotechnology companies. The basic dilemma for farmers is the making of the selection of the type of seed and the related production technology. The offers of agricultural biotechnology companies compete with conventional seeds (hybrids), organic seeds, and local varieties (regional varieties) and their respective production processes. Attention must be called to the fact that literature dealing with the topic almost solely compares GM and conventional (hybrid) products and barely any deals with the possibilities of organic farming and regional varieties. This distortion can be explained by the fact that the majority of farmers in developed countries farm in an intensive and industrial manner, which is best served by the former two alternatives (GM and hybrid). At the same time, the various forms of organic farming practices are gaining substantial ground in developed countries due to increasing consumer demand and a significant price premium which can be kept by the farmer. Therefore it would be important for long term agricultural policies to compare GM and organic products. Although the in situ (that is locally, at the site of farming) preservation of the genetic diversity of cultivated crops is not negligible in the case of developed countries, for such reasons that the market price of produce can be increased with regional qualities, the existence and preservation of regional varieties is especially important for the poorer farmers in developing countries, as the avoidance of risks and the stabilizing of income is much more important in their farming than maximizing their profits. The conclusion that can be drawn from the above is that farmers cannot be considered a homogeneous group either within regions or within countries. The diversity of farmers is apparent in the decisions they

make in regard to seeds and production technologies (motivation, economic interests, cultural approaches, their devotion to genetic diversity, etc.). Unfortunately literature, especially that which implements economic models and performs ex ante analyses, does not take into account the heterogeneous nature of farmers and assumes universal motivation, characteristically in the form of an approach that is neutral to risk and strives toward profit maximization. Therefore, in our summary detailed below in which we aim to comprehensively introduce the effects of first generation GM crops experienced on the level of farmers, we do not take into account those studies that assume the homogeneity of farmers.[4] We concentrate on those analyses that do not make this elemental mistake.

*Figure 3* *Genetically modified organisms in the food supply chain*




**Source: DG Agriculture (2000), pg. 3**

Further examining the effects of agricultural biotechnology on the food supply chain, the next key players are food producers and food businesses (primarily food retail chains). The food supply chain has become global and this point has taken on an exceedingly important role, since the changing and increasingly fragmented consumer demand feels and provides feedback to the players at the beginning of the chain. The establishing and operation of giant retail companies (such as Carrefour, Metro, Wal-Mart, etc.) determines in large part the food supply chain. A good example of the economic strength of these players in the chain is that, according to estimates, 50-70% of the net profit of these giant retail companies is derived from the prices of renting out the shelves (Heffernan et al. quote Wilkinson, 2002). Thus, a deciding question in the spreading of agricultural biotechnology is the type of strategy food retail chains will apply and what sort of requirements they will impose towards the players further up on the chain.

[4] Among other reasons, this is why we dot discuss the only ex ante economic analysis concerning Hungary that we know of, the work of Demont et al. (2005). Unfortunately, this assessment is not only burdened by the mistake detailed above, but with numerous others as well (including the incertitude of data, the discrepancy between the applied model and the conclusions arrived at, etc.), and can therefore not be considered a viable analysis in the evaluation of the expected results of the application of agricultural biotechnology.

Naturally consumers are at the other end of the food supply chain. Their role in the increasing of market shares of agricultural biotechnology products is also prominent. This can be seen by the fact that the acceptance or opposing behaviour of consumers played an important part in allowing or not allowing first generation GM plants into the food supply chain. Consumer protection organizations and consumer boycotts, primarily focused in Europe, defined and define today the present and future prospects of the spreading of agricultural biotechnology products on the market. The standpoint of European consumers also had and has today a global effect on the globalised food supply chain. Countries, companies, and farmers wishing to export their products into the EU have all had to adapt themselves to the expectations of their rich export markets. And these, as we shall see below, are detrimental to the spreading and market success of agricultural biotechnology products not only in Europe but in an increasing number of countries.

## *3.1. Experiences on the farmer level*

When evaluating the supply chain, it can be seen that the first important role is played by farmers, who make the decision of what kind of seed to buy and use, as well as decide the type of related farming technology that will be applied. We saw before that the area on which GM plants are produced increased quickly following their introduction in 1996 despite the fact that their production is limited to only a few countries. The question thus rightfully arises of what advantages this new technology has in store for farmers. What are those economic reasons, if there are any, of GM plants spreading so quickly in those countries? Is it worth it for farmers in other countries to utilize agricultural biotechnology? Numerous answers have been given to these questions that have been arrived at through very different methodological analyse that differ even in the data they take into account. It seems to be actually impossible to draw any generally true conclusion besides that the analyses made on the level of the farming units show a mixed picture due to the fact that besides the technology itself, other aspects also influence its success.

According to the promises of the technology, first generation GM plants can be expected to reduce the costs of plant protection and also provide better yield. At the same time, they are more expensive than traditional (hybrid) seeds, as the developing company aims to validate its value inducing investment through a technology fee. The success of GM crops is influenced by their yield, the price of the seed, and the cost of providing protection against pests.

According to DG Agriculture (2000), herbicide resistant GM soybean (hereinafter referred to HT soybean) results in a 15 EUR surplus cost to farmers per hectare, which is a 35% price premium compared to the price of conventional soybean seed. According to the most common estimate, the price premium in the case of Bt maize is 22 EUR/ha. (pg. 17)

It is not clear in the case of herbicide resistant GM plants whether the cost of herbicides is less than conventional herbicide technologies. The existing comparative data fluctuate widely. The data can be understood as being conflicting since the total amount of herbicides belonging to herbicide resistant GM varieties (resistant to the specific herbicide) has risen while the use of other synthetic herbicides has dropped, although according to the USDA, this leads to a drop in the total amount of used herbicides. The USDA also states that the use of pesticides is much lower in the case of Bt-maize than with conventional varieties (see also Shoemaker, 2001). However, other sources do not feel the situation is that simply advantageous and indicate a slight increase in the costs of pesticides, herbicides, and fertilizers (DG Agriculture, 2000, pg. 17). In regard to the use of plant protection products, the study that is methodologically the most in depth and which has been referred to the most was prepared by Benbrook (2004) and states that the statement made by those in favour of agricultural biotechnology according to which GM crops reduce the need for plant protection products was found to be true for the first three years (1996-1998). However, the situation has changed since 1999 and the statement is no longer true:

> "The production of GM maize, soybean, and cotton has led to a total increase of 55 million tonnes in the amount of plant protection products used since 1996 [between 1996 and 2003]. While the production of Bt plants has caused a 7 million tonne decrease in the amount of pesticides used, herbicide resistant GM plants have increased the amount of distributed herbicides by 62 million tonnes during the same period. Bt varieties have led to an approximate decrease of 5 % in the amount of pesticides used in the production of maize and cotton while the biotechnology approaches to herbicide resistance have increased the amount of herbicides used in the three main crops by 5%." (Benbrook, 2004, pg. 2)

Benbrook (2004) also calls attention to the fact that those ecological forecasts that predicted the relatively quick adaptation of weeds to the herbicide resistant biotechnology applications have proven to be true. In the case of the most widespread Roundup Ready GM plants developed and distributed by Monsanto, the development of resistant weeds (pg. 3) took place in three to four years, and from this point on, the "pesticide wheel" is once again set in its circular motion. The American writer also points out those factors that together undermine the effectiveness of herbicide resistant biotechnology. These three factors are the development and spreading of resistant weeds; the increasingly difficult nature of procuring conventional (non-GM) plant seeds; and the drastic decrease in the price of herbicide costs in the increasingly competitive race for market share. Benbrook (2004) feels that in the near future, the participation of herbicide resistant GM plants to the increased use of plant protection products will suppress the decrease that results from the production of Bt plants (pg. 4), and it is therefore unfounded to link agricultural biotechnology with the decrease in plant protection products and the resulting environmental protection advantage.

Regarding yield, the results in the case of Bt maize are promising: numerous studies show its advantages in yield compared conventional varieties. However, they also indicate that seasonal changes in climatic conditions and pest attacks can significantly alter these results. The summaries of Shoemaker (2001) and Runge-Ryan (2003) report of smaller increase in yield in the case of HT soybean and larger increase in the case of HT cotton (pg. 11 and pg. 32, respectively). Conversely, in the case of HT soybean the DG Agriculture (2000) records a lower yield than that of conventional varieties. One reason for this is that the herbicide resistant gene was not "implanted" in the variety with the largest yield. It is important to stress that the first generation GM plants aim at special production conditions (for example, pests and weeds) and they do not strive to increase the yields of these plants directly (increase is planned by the decrease of damage and loss in yields). However, the yield comparisons in the case of GM and conventional crops depend upon the growing conditions, thus also including the regional characteristics of the production area, especially the prominence of pests and weeds (DG Agriculture, 2000, pg. 18; with which the conclusions of Shoemaker, 2001, pg. 14 are also in concordance).

According to a study by the DG Agriculture (2000), we are still lacking proof beyond a doubt regarding the fact of whether GM crops do indeed provide the farmer with a profit. On the basis of clearing costs per hectare, there is no significant difference between HT soybean and its conventional partner; the cost effectiveness of Bt maize depends on the degree of European corn borer infestation; and there is also no clear conclusion in the case of HT rapeseed regarding its economic profitability over its conventional counterparts. Shoemaker's (2001) summary states that the use of HT cotton has increased the income generated by farmers the same conclusion cannot be drawn in the case of HT maize and HT soybean; in the case of Bt maize, the increase in revenue compensated them for the higher cost of the seed, thus resulting in increased profits. At the same time, the study also stresses that herbicide resistant and pest resistant GM plants grant their users economic benefits above a certain level of infection (pg. 12 – see also Kalaitzandonakes, 1999). Runge–Ryan (2003) shows more optimistic results in the summary

concerning the profitability of GM plants in the United States. Referring to several regional studies, they draw the conclusion that the spreading of the first generation GM crops in the United States can be understood especially in the case of genetically modified soybean, maize, and cotton, since "these varieties generally result in larger revenues and are easier to handle compared to their conventional counterparts" (pg. 33). Even the DG Agriculture (2000) calls attention to the fact that the most obvious and direct success of GM crops (primarily HT varieties) is the combination of performance (not necessarily only measured in yield) and degree of ease they provide. They guarantee a greater degree of flexibility in farming practice, as the work they need is smaller and more flexible. Comfort manifests itself in the increase in the productivity of the work and in the decreasing of plant specific work costs. Analyses that evaluate the profitability tend to forget this latter factor (pg. 18).

It is worth taking those theoretical economic models into account that attempt to analyse the costs and benefits that arise at the level of the farmer. Huang and his associates (2003) examined the effects that the production of a genetically modified cotton variety (Bt cotton) had in North China. Farmers that switched over to the growing of Bt cotton applied plant protection products 6-7 times on average, while conventional growers used the same products 20 times on average. Plant protection products that were used less frequently naturally resulted in a savings in costs for those who grew Bt cotton, which savings were realized in the costs of plant protection products and labour. Although the farmers did not experience similar advantageous results in their income, the savings they had in costs increased the profitability of those farmers who grew Bt cotton. In regard to this and similar analyses based on econometric models, Pemsl and colleagues (2008) pointed out that although they are good at pointing out the advantages and disadvantages of static productivity, they are little suited to take into account the dynamic interactions between the steps taken against pests and the given ecosystem. The writers offer bio-economic models for this approach. They developed and tested their model for the Bt cotton grown in North China as well. Their results show that yields will vary depending on the degree of degradation in the given ecosystem; the lowest yields will be gained in the case of all varieties (both GM and conventional) in areas with the most serious degradation in the ecosystem. It follows that if farmers in North China farm in an agricultural ecosystem that shows serious degradation due to earlier use of plant protection products, it is not at all surprising that the Bt technology will lead to higher yields compared to the natural pest control strategy (Pemsl et al., 2008, pg. 182).

Several analyses have been made concerning the experiences of Bt cotton farming in India. After the United States and China, India is the third largest grower of cotton in the world and makes up 12% of the world's cotton export and 20% of the total area on which cotton is grown. However, average yields in India are substantially lower than the world average due to the infestation of pests. Starting in 2002, India granted approval for Bt cotton to be grown. Bennett and his collaborators (2006) performed their analysis in the state of Maharashtra, where the total area on which Bt cotton is grown increased from 12,000 hectares in 2002 to 530,000 hectares in 2004. On the basis of an examination of production data concerning industrial production, the farmers who grew Bt cotton varieties experienced a significant increase of 33-48% in yield. They note however, that this result could have been influenced by not only the applied genetic modification but the hybrid itself (meaning its production yield) that was used for the development of the Bt varieties. On the basis of their analysis, the effect that the more effective farmers took to producing Bt varieties again cannot be ruled, and they may have produced these varieties on soil with better conditions and/or proceeded with more diligence; these factors could have manifested some affects on the differences in yield.

Roy and co-authors (2007) conducted an analysis in the area of the cotton growers of Gujarat. They especially stressed the context of their study, which is the fact that the cotton growers of Gujarat have a unique strategy of conducting experiments with various varieties. Their results indicate that the cotton growers of Gujarat knowingly avoid depending on only one variety and choose to experiment with several varieties even if Bt monocultures promise very good yields. In all, Bt varieties result in advantages for the majority of farmers in protection against pests. Most farmers who are involved in the production of Bt varieties experience short term savings due to a decreased amount of necessary plant protection products. At the same time, the majority of farmers did not adhere to the recommendations regarding the refugium zone. The authors also call attention to the fact that if an effective credit system is not operational for the support of less affluent farmers, they will be incapable of purchasing the more expensive official varieties. The experimenting strategy followed by the cotton producers of Gujarat also meant that they incorporated the GM varieties into their risk avoiding production strategy and used them in their "seed mixes." Roy and associates (2207) also point out the fact that the unique knowledge and adaptability of the farmers makes it necessary for them to have a say in agricultural policies concerning the direction and opportunities of developments of agricultural developments.

Another analysis of Bennett and co-authors (2006) dealt with the effects of the spreading of Bt cotton in the South African region of Makhathini. Their study is especially interesting as it examined the situation of poor small holders. The results indicate that the bad position of this farming society experienced an increase in benefits from the GM variety in the form of increases in yield, smaller amounts of necessary plant protection products, and also decreased labour costs. However, the authors also called attention to the fact that the spreading of GM varieties not only resulted in benefits, but also led to certain problems. Since no wild relatives of cotton inhabit the region, the risk of the modified gene spreading in the wild is not relevant. The hazard of the Bt resistance failing in the long run does however prove a threat, as only half of farmers applied a refugium in accordance with the guidelines. The authors also noted that farmers are too much at the mercy of seed companies that hold monopolistic situations, which can cause a problem even if the company split profits in a 78-22 percentage ratio to the benefit of the farmers in the first three years of production.

An important study that was aimed to fill a missing gap was conducted by Soleri and co-authors (2008) regarding the motivation to buy seeds of farmers in developing countries. Small parcel farms fulfil important food supply tasks in these countries as well and are expected to continue doing so in the future. In fact, these farmers are the main guarders of the genetic diversity of cultivated crops. They use traditional farming practices in their farms and thus play an important role in the maintenance of in situ biodiversity. A richness of culture and language is also closely linked to a high level of diversity in cultivated crops, meaning that their farming traditions are important both in the upkeep of biological and cultural diversity. Therefore it is especially important to examine the motivation that leads these types of farmers to make their decisions concerning seeds. The study of Soleri et al. (2008) is unique as most literature generally compares GM crops with conventional varieties on the level of the farmer and they fail to examine regional varieties. However, this study was conducted by making 334 interviews in two farming communities each on the countries of Cuba, Guatemala, and Mexico in order to prepare a survey on the seed preferences of farmers. According to one of their main findings, farmers felt that local and regional varieties had the home advantage in comparison to GM varieties, traditional (hybrid) varieties, and plant bred (improved) local varieties in the case of utilization for both seed and own food resources. According to another important finding, the majority of farmers avoid taking risks (and are not neutral to taking risks, as most literature involving economic models assume) and prefer those varieties that have smaller variances and risks but also provide smaller average yields to those varieties that have higher yields but also larger variances in production and higher risk factors. The researchers also found that the farmers preferred all other varieties to GM varieties.

For their own food, they rejected GM varieties even more than as seeds. It is important to note that farmers who prefer local varieties, who are the in situ maintainers of planted biological diversity of plants, and who are not part of the formal seed system and market are more a part of the informal seed network. Those farmers who are better integrated in the formal seed system and market are rather neutral to risk and tend to maximize average yields in their decisions concerning seed selection; thus, their approach to GM varieties is more open.[5]

Since Hungary is not involved in the commercial growing of GM plants, there is no experience regarding Hungarian farmers and the farming environment. The research presented by Bánáti and co-authors (2007) sheds light on the approach of Hungarian farmers. They used a survey to examine the attitude of the main players in the domestic food supply chain towards GM products. They came to the following main conclusions regarding the farmers:

- Hungarian farmers are rather negative towards GMOs: they do not agree with the statement that a competitive drawback would arise from failing to produce GM crops; the possibility of having to apply a smaller amount of plant protection products is not a strong enough reason for their introduction; however, they do agree that their use should be avoided due to the lack of knowledge concerning the effects of their production and also support their being handled differently (Bánáti et al., 2007, pg. 146).

- Plant producing farmers, who are the most directly affected by the putting into production of first generation GM crops, are the least tolerant and are the most disinclined towards GM products compared to the two other surveyed groups, animal breeders and agricultural suppliers (ib., pg. 147).

Studies regarding Hungary have also been prepared by the AKI (2005) and Popp and Potori (2007), which are ex ante analyses. AKI (2005) models the opportunities of producers of maize, rapeseed, and sugar beet for the period between 2004 and 2008 on the basis of a partial equilibrium model. In order to complete the calculations, the assumptions certain macroeconomic variables use must be separately determined as an exterior factor regarding the yields of the three crops, the circumstances of profitability, and domestic consumption (pgs. 5-6). Thus, among others, the study assumed that the results of the studies concerning the profitability results of the Bt maize grown in Spain (a plus income of 47 EUR/ha) can be realized under the growing conditions prevalent in Hungary as well (pg. 6). The main results of the model are as follows:

- An average yield of 1 million tons of GM maize is expected for the studied period, for which there will be neither a need as human consumption nor as industrial use as feed, and sales on the export market of GM maize products is not profitable, either (pg. 11). The production of GM maize would result in a 1.5 % increase in income for farmers (pg. 12).

[5] The genetic diversity and the maintenance of regional varieties is a very important issue for Hungary as well. In regard to the situation of in situ protection in Hungary and for an analysis of the motivation of Hungarian farmers, see Balázs et al. (2004), Birol et al. (2005), and Birol et al. (2006).

- GM rapeseed would be grown on 25% of the total land on which rapeseed is grown; the model foretells a 3.8-4.4% increase in income for farmers due to biofuel production and the increase in demand (pgs. 11-12).

Utilizing the test database of the Agricultural Economics Research Institute (Agrárgazdasági Kutató Intézet), Popp-Potori (2007) modelled the possible spreading and effects of GM maize in Hungary. According to their model calculations, the area on which GM maize is grown would be around 120,000 – 180,000 hectares in 2012, which is about 10% of the total area on which maize is grown and less than 1% of the farms that grow maize. As a result of diminished fungicide and pesticide use, the forecast includes a decrease in costs of 8000 HUF/ ha for those farms that do implement the production of GM maize. According to their results, whether it would be profitable to grow GM maize depends on the purchase price of GM maize seed (more specifically, on the difference between the purchase price of seeds of GM varieties and conventional seeds).

It is clearly illustrated that ex ante economic assessments performed in Hungary do not provide particularly attractive or beneficial results in regard to the growing of GM crops, although the exogenous variables are optimistic concerning the development of conditions.

## *3.2. Experiences on the level of the food industry*

Commercial food retail plays a prominent role in the supply chain. By practically "blowing up" the preferences of consumers, the steps taken and decisions made by retail companies have a definitive effect both on food processors and seed producers, as well as farmers. Through the process of food supply chains becoming global, the strategic steps taken by European commercial food retailers will have effects that extend beyond the orders of Europe.

Starting in the 1990's, the European food industry has experienced increasing troubles on behalf of public opinion with regard to the quality of foods and food safety. The majority of European consumers are especially wary since the 1996 British BSE crisis. Among European consumers, GM foods pose yet another threatening unknown among food safety scandals. It is no surprise then that the European food industry has experienced numerous protests and boycotts on behalf of their consumers in regard to GM foods.

The competition strategies of food business operators and commercial retailers in the food sector are increasingly based on building values attributed to high quality products and those that are affixed with brand names. The developing and use of own brands and labels is a strategy used to especially good effect in the case of companies ruling retail commerce. This competitive strategy also includes the companies having to take greater responsibility and undertaking greater risks in the maintaining of the quality of food products. This means that the fears and worries of consumers regarding the safety of food products are unequivocally linked to the financial performance of companies and their position on the competitive market. All these provide an important background for the understanding of how the European food industry reacted and reacts today to the appearance of GM products.

European commercial food business operators reacted from 1998 onwards (first in the United Kingdom and then in the rest of continental Europe) to the appearance of first generation GM crops by voluntarily affixing their own brands with GM labels as a result of appreciating the resistance they met on behalf of consumers. These steps were based on the GM ingredients found in the products, which were later regulated by the legislation of the EU. Numerous players on the market with important market power took independent steps that not only took the contents of the products into consideration, but also the production process. At the initiation of Sainsbury's, six European commercial chains (French Carrefour, Belgian Delhaize, Italian Esselunga, British

Marks & Spencer, Swiss Migros, and Irish Superquinn) formed a consortium to reorganize their supply chains with their united strength. In Austria and Germany, the whole of the industry took steps toward "negative" labelling by affixing "GM free" inscriptions on their products. Others aimed at preserving their GM-free images toward their worrisome consumers by laying emphasis on bio-foods originating from ecologically friendly farms. In all, a large portion of commercial retailers as well as the largest food producing companies took steps to ensure that their supply chains guaranteed freedom from GM products and also documented these steps and communicated them to their consumers. A number of small retail chains (including Sainsbury's, Marks & Spencer, Safeway, and Northern Foods) has gone so far as to ban any meat products that have been produced through the use of giving the animals first generation GM plants as feed.

Second generation GM plants aim at the final characteristics of food products and the production process. These GM solutions manifest themselves in the modification of nutritional values. Among others, such genetic modifications include the increasing of micronutrient content, the decreasing of fatty acid content, the decreasing of sugar content, or the transformation of any of these. In order or second generation GM plants to become successful and overcome the hesitations of consumers, they have to drive past certain uncertainties. The advantages experienced in the food production process are still surrounded by a mist of uncertainty. The research and development (R+D) endeavours of the largest seed production companies are concentrated on the most important cultivated crops (soybean, grains, sugar beet, rapeseed), since these plants have the largest seed markets and are thus the most alluring. However, food producers are little interested in the modified character traits of these plants and are much more interested in the products that they sell directly to their customers; however, these products are often backed by much smaller seed markets (for instance: coffee, cacao, and chicory). There is even a conflict of interest between food producers and seed producing companies in that the former would be interested in having sole rights to the seeds that have these new qualities in order to increase their competitiveness, while for the latter this would only result in setting limitations in the market. It cannot be ruled out; in fact it is very probable, that these nutriceutical products will result in evoking new consumer worries and protest, which will further decrease the amount of trust in the food industry and its brands.

Thus, as a result of consumer worries and expectations, food industry companies have changed their business practices regarding the supply chain all across Europe and put an increasing amount of pressure on the decisions that affect the agricultural inputs of farmers. In the case of the first generation GM crops, these companies clearly exerted pressure on farmers to refrain from using the related technological developments. In order to protect heir brand names, aspects of quality, reputations, and finally their competitiveness, the powerful players in the food supply chain attempt to avoid using any GM components in their supply chains. This pressure spurred by economic interest plays a very important role in the degree of spreading of GM plants and products that contain GM plants. (Levidow–Bijman, 2002)

Previous EU regulations and the EU legislation concerning labelling that entered into force in April 2004 have strengthened the economic processes detailed above and products containing GM components have practically disappeared for the shelves of stores of food commercial companies. Producers have opted to alter the contents of their products and distributors have chosen to reject for sale any products that contained GM products. (Gruére, 2006)

In an analysis comparing Canada and France, Gruére (2006) also calls attention to the possibility that although in Canada, the federal state has provided for the possibility of individual labelling, the behaviour of a single member state can change the situation in Canada over time. The province of Quebec is experiencing significant opposition to GM products, and the government of the province is searching for the possibility of making labelling mandatory on a federal level, as well. Although this application of pressure is not likely to lead to quick results at the federal government, if Quebec were to introduce mandatory labelling for the products distributed within its own boundaries, this would have a big affect on the strategy of food industry companies. The sector would have to choose between the following steps: (i) they could keep GM components and would only provide their products with new labels in the province of Quebec; (ii) they would choose to distribute solely GM-free products in Quebec; (iii) they would ensure all their products are free of GM components. The second option would be quite costly, and would be contrary to the principle of the economic rationality of a unified strategy on integrated markets. If they were to be scared of the opposition experienced in Quebec spreading to the other provinces of Canada, the first option would also become unfeasible. This would mean that the third option seems to have the best foundation.- This theoretical experiment definitely shows surprising outcomes fort he possibilities inherent in the limitations of the spreading of GM plants.

Knight and co-authors (2005) also examine the reactions of the supply chain, although instead of on the level of food industry companies, they study the country's image. Their study takes us to New Zealand, where a very important point in the societal discussion over GM plants is that the country could lose its "clean and green" image, and this could lead to its losing its export markets if the production of GM plants is allowed. It is worth noting that in its main export markets, the EU and Japan, the majority of consumers reject the consumption of GM foods.

The difficulty of the decision and the contradictions of the situation were not eased by the fact that the Royal Commission on GM published a four volume report during the societal discussion that cost 6.5 million NZD. The main conclusion of the report was the following:

> "New Zealand must leave the opportunity to decide available. It would not be wise to turn our backs on a potentially advantageous offer, but we have to proceed cautiously to decrease to a minimum the possible risks." (as quoted by Knight et al., 2005, pg. 387)

The researchers conducted in-depth interviews with the leaders of companies importing, distributing, and putting into circulation the export products of New Zealand (in the countries of the United Kingdom, The Netherland, Germany, and Italy). The main conclusions are as follows:

- According to the replies, European consumers will not change their negative feelings toward GM products in the short term.
- The opportunity for producing new products through the genetic modification of livestock was met with unequivocal rejection.
- The possibility of the genetic modification of the plants on pasture was also met with a negative reaction.
- According to the survey, the production of GM plants does not put the country in a bad light. (Knight et al., 2005, pg. 391)

In all, it can be seen that although the consumers of the export markets oppose GM products, the production of GM plants in New Zealand does not lead to a loss in the "clean and green" image of

the country. It is worthwhile taking a look at this result in light of the public opinion in New Zealand. Cyole and Fairweather (2005) quote the results of a regional survey conducted by New Zealand newspaper (The Press), according to which 66% of those surveyed felt that "the production of GMOs would have a negative effect on New Zealand's clean and green image" (pg. 154). This same authorial pair refers to a study commissioned by the New Zealand Ministry for the Environment and prepared by the Lincoln University, which came to opposing conclusions as Knight and co-authors (2005). According to this study, the country's brand image would be significantly devaluated by the production of GMOs (Coyle-Fairweather, 2005, pg. 154). Whether the "GM-free New Zealand" brand would provide advantageous on the market remains an open question, as the study performed by Knight et al. (2005) merely showed that the production of GM plants in itself does not necessarily lead to decrease in the country's image.

As a good supplement, the totally different analysis of Anderson and Jackson (2005) is a good connection. The economist authors examine the question of how food exporting countries such as Australia and New Zealand weigh the possible advantages of agricultural biotechnology as opposed to those possible costs that could arise in regard to the production of GM plants due to ecological production consequences, the consequences of losing market share due to the loss of the "clean, green ,and safe" image, and the establishment of systems aiming at preventing any possible accidental mixing in the supply chain and preserving identity (SIP = Segregation and Identity Preservation). On the basis of the simulations of the general equilibrium model, one of the main conclusions the authors arrived at is that if European and Asian markets fail to allow GM products in, then the production of GM products will lead Australia and New Zealand to decrease their well being. The benefits of producing GM crops by food exporting countries are primarily based on the acceptance of the consumers in the domestic and export markets as well as the costs of the systems of segregation and identity protection. Anderson and Jackson (2005) therefore feel that it is understandable and rational for Australia (with the exception of Queensland) and New Zealand to wait with the spreading of the production of GM plants on an industrial scale. As they put it:

> "Therefore, although the above analysis does not provide strong reasons for Australia and New Zealand to give up their present limitations, the cost – benefit analysis of the termination of the moratorium on the industrial production of GM products will change over time, and these changes must be followed." (Anderson–Jackson, 2005, pg. 279.)

The various provinces within Australia display varying stances regarding the GMO issue. Having changed their previous viewpoint of supporting GM plants, the provinces of Tasmania and Victoria have passed a moratorium on the production of GM plants for industrial use (the former in 2001 and the latter in 2004). Their changes in opinion are expressly substantiated by the previous reasons: they have to protect their states' image from the risk of GM plant production, which endangers the "clean and green" reputation they have on the international market. The market advantages of GM-free status are summarized in the following by the commissioned experts (Expert Group on Gene Technology, quoted by Cocklin et al., 2008, pg. 165):

> "Tasmania, as a niche producer of foods and drinks, can in all likelihood cultivate a market advantage if it refrains from applying gene technologies until the sensitivity of both domestic and international markets decreases."

The province of Victoria similarly felt that its main export markets in the case of dairy products, Japan and South Korea, expected GM free feed, that is total freedom from GM products in the whole of the supply chain. Therefore both of the largest dairy companies in Victoria exerted pressure on both Australian farmers and the state government to help maintain its market position and guarantee its distinction on the market. The economic risks arising from the production of

GMOs thus prove to be a big enough pressure for the policies of the state of Victoria to be changed. Presently all provinces of Australia, with the exception of Queensland, has issued a moratorium on the production of GMOs. (Cocklin et al., 2008)

On the basis of surveys, it can be established that it is not too risky to state that the maintenance of the GMO free national image is, at the worst, cautious (but causes no losses), and, in a better case, a winning strategy until the time consumers of the domestic and export markets of the given country have no more feelings of antipathy against GM products.

The only study regarding Hungary was prepared by Bánáti and associates (2007). Their survey study previously referred to was conducted in regard to the whole of the food supply chain. Their published research report only includes the approach of food producers and does not state whether the approach of distributors and commercial players is known. The necessity of the studies is also shown by the fact that a quarter of domestic food producers regard the appearance of derivatives produced from GM plants as an everyday task; within this sector, the participants of the animal products chain are the most affected (pg. 150). Of these concerned companies, the majority request a declaration from their suppliers regarding freedom from GM contents, while a minority (one fourth) also has laboratory tests performed to examine the truth of this declaration. On the basis of the provided answers, 66% of these companies have found their suppliers to provide false declarations, and so it is no accident that half of those taking the survey admit they cannot guarantee freedom from GM products (pg. 151). Concerning the approach of food producers, it is worth stressing that they hold themselves to be insufficiently prepared and domestic regulations to be insufficiently stringent (pgs. 152-153). Due to the shortcomings felt in this latter field, the trust shown by consumers can be led to decrease, which results in deteriorated competitiveness (pgs. 155). Views provided by food producers show that they feel the consumer demand for labelling (indication of GM products) is justified and generally support Hungary being declared a GM free zone (pgs. 153-154).

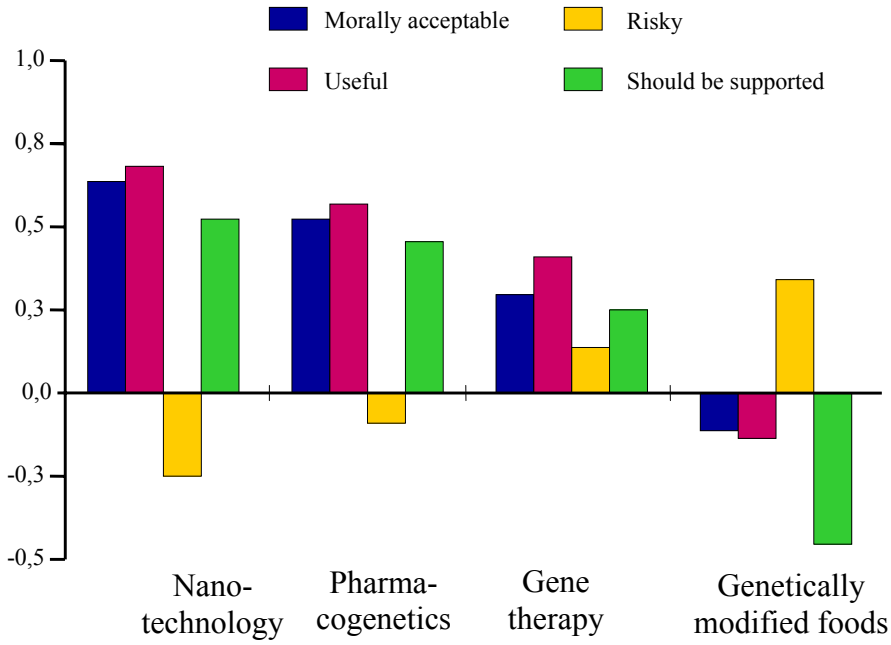
## *3.3. Experiences on the level of the end consumer*

At the end of the food supply chain we find the consumer, who chooses from among the offered products and services in the interest of his own and his community's well being. The expectations, attitude, and professed values as well as the values actually exercised in the making of the consumer decision have an affect on the other members of the supply chain in all cases. The history of agricultural biotechnology shows a tempestuous picture concerning consumers' acceptance. There are substantial differences between both the approach and the behaviour shown by consumers of various countries. This field of research is very extensive and a very large number of both small and large studies are being performed with the aim of shedding light on the agricultural biotechnology preferences of consumers. In the following, we concentrate mostly and summarize in detail on the studies that deal with the consumers of agricultural biotechnology in Hungary. We only mention the conclusions and results of those international studies that we found to be the most general, the most characteristic, and the most useful.

### 3.3.1. Consumers in light of international research

According to a study by Eurobarometer, consumers in the European Union are generally optimistic concerning technological innovations and are generally also for biotechnology. They also hold nanotechnology, pharmacogenetics, and even, although they feel it is risky, gene therapy, to be useful technologies. However, the support of red (health) and white (industrial) biotechnology is not accompanied by the acceptance of green biotechnology. The modification of genes for agricultural purposes is generally looked upon negatively by EU citizens. According to their opinion, it is not useful, is morally unacceptable, and poses a risk for society.

*Figure 4* *Biotechnologies as seen by European consumers*




**Source: Gaskell et al. (2006): 17**

Regarding the general optimism towards biotechnology, the previous six surveys seem to point towards the tendency that this optimism was reduced between the years 1991 and 1999 in the EU Member States (with the exceptions of Holland and Germany, where the level of acceptance has become better towards the end of the decade) and then this same index increased in all the EU 15 countries between the years of 1999 and 2005 (with the exception of Austria). It should be noted that the distance between the extreme figures was very big (on a scale from zero to one hundred: Spain recorded 75 points for the highest figure while Greece recorded 19 points as the lowest figure in the 2005 survey in the EU 15; among the newly acceding 10 countries, Malta recorded 81 points and Slovenia generated 7 points to form the maximum and the minimum) (Gaskell et al., 2006, pg. 13).

However, within biotechnology, the support for genetically modified foods does not follow this same trend. Once again, the data of the EU 15 states is available for the illustration of this tendency. In these figures, a strong decrease can be experienced between the years of 1996 and 1999 regarding the support of GM foods, which is then followed by growth up until 2002. The next period once again shows a significant decrease strong enough for 2005 figures to drop below the 1996 level in several countries (Gaskell et al., 2006, pg. 21).

If we concentrate on those who are informed and have opinions, meaning those who gave valid answers to all questions concerning GMOs, then the results show that 58 % of the total EU population was against agricultural biotechnology in 2005 and 42 % was for it.

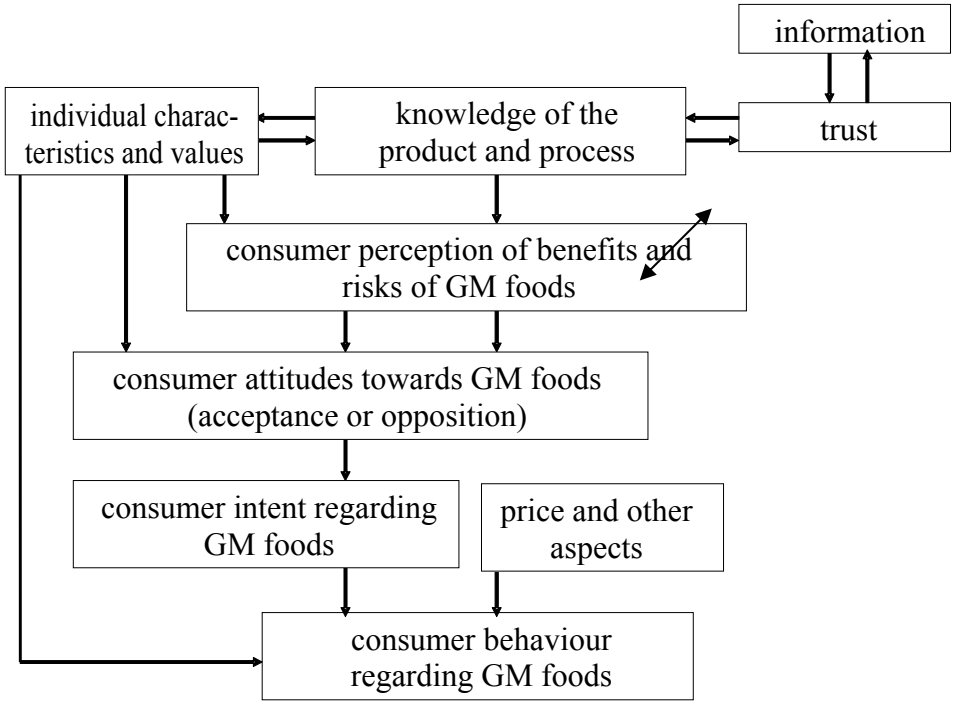
The reasons that were behind the intent of buying GM food products were also researched. On an EU level, 56 % of those who responded to the survey would definitely buy or would be likely to buy GM foods if they were proven to be healthier and 51 % if they contained smaller amounts of plant protection products. These are the two most appealing arguments, which are followed by a

reduction in environmental impact. The least convincing reason for consumers is the permission granted by local authorities and lower prices. It should be noted that in certain European countries, more than half of those who responded to the survey did not accept any of the arguments, meaning that none of those was convincing enough for the consumer to buy GM food. The majority of those who showed opposition reside in Austria, Greece, Hungary, Germany, and Latvia while the least can be found in Malta, Czech Republic, Holland, Spain, Belgium, and Portugal. The authors of the study also stress that those who are not opposed have very many reasons for choosing to support GM foods. The authors then draw the conclusion that is a minimal degree of acceptance is present in people, they are likely to find numerous reasons to support the purchase of GM foods (Gaskell et al., 2006, pgs. 22-23).

It also worthy noting how people feel science and, more specifically, biotechnology should be controlled and the decisions regarding these fields should be made. 59 % of the respondents in the EU 25 trusts in science: they feel that the proof science provides and the scientists involved are a good source for making the relevant decisions. However, close to a quarter of those who participated in the survey feels that these issues should not be decided by scientists and that professionals should not argue these matters amongst themselves without including those who are concerned as well as the general public. More than 30 % of the respondents would make not the proofs provided by science the basis for the decisions, but moral arguments (Gaskell et al., 2006, pg. 45).

Costa-Font and co-authors (2008) summarized the results of the studies prepared in the last 10 years concerning the attitude of consumers regarding gene modifications and foods prepared with genetic technologies. Regarding consumer attitudes, the research they refer to generally show a strong opposition to GM foods in not only Europe, but they note that results in America do not vary greatly from the European counterparts. Costa-Font et al. (2008) find that the studies only research and explain certain aspects of consumer attitudes. However, on the basis of a compilation of all the research, they feel that a model can be seen that explains the attitude of consumers regarding GM foods, including their buying preferences and consumer behaviour.

*Figure 5 The factors of consumer behaviour regarding GM food products*




**Source: Costa-Font et al. (2008, pg. 108)**

According to their results, consumer attitudes are determined by three main factor groups: the perception of benefits and risks; personal characteristics and values; and the consumer's knowledge as well as the relationship between the consumer's knowledge and values (Costa-Font et al., 2008).

- **the perception of benefits and risks**

The overwhelming majority of studies show that consumers do not feel that the benefits associated with GM food products surpass the inherent risks. Especially the northern countries of Europe, Great Britain, and Germany belong to this group, while the perception of benefits is slightly stronger than the risks in the United States and in certain European countries, such as Italy and Spain. In summary, the modified characteristics of the GM products available today (resistance against pests and plant protection products), despite the fact that they aim at reducing the costs of food for the consumer, are complex characteristics that the consumers do not feel benefit themselves, especially in light of the increased degree of risk (Costa-Font et al., 2008). Gaskell and associates (2004) declare outright that the Achilles heel of GM foods is not the misunderstanding of the scientific risks on behalf of the public, but the lack of benefits that the consumer perceives. On the basis of the 1999 Eurobarometer quantitative study and its supplementary qualitative study, they feel that in the eyes of a large group of European consumers, it is not the risks inherent in GM foods that are relevant, but the lack of benefits that these products provide. In contrast, a larger percentage of American consumers see benefits in GM foods (pg. 193). The qualitative (focus group) research done by Lassen and Jamison (2006) also stresses the importance of these benefits. They feel that among other things, the wider acceptance gained by the use of biotechnology in the health sector compared to agricultural biotechnology is attributable to the following: societal benefits are clearer in the former than in the latter, in the case of which these seem superfluous to a significant part of consumers. On the basis of their Danish empirical study, the authors also emphasize that the benefits are not

understood by the common consumer on an individual level, but at the level of society and are not reduced to solely benefits on an economic scale, either (pgs. 17-18). According to the participating Danish consumers, the argument that agricultural biotechnology results in gains and economic profits is not strong enough (pg. 21).

- **personal characteristics and values: societal-economic and demographical characteristics, ethical considerations, religiousness, etc.**

In the study of personal and individual characteristics, the studies examined by Costa-Font et al. (2008) came to results that varied greatly. It is perhaps safe to say that there is no relationship that is true for all the studies and that is substantiated by all the results between these characteristics and consumer attitudes toward GM products. It is worth stressing the point that several studies (including the latest Eurobarometer) have come to the conclusion that women see less advantages in genetic modifications that men and are also less acceptant toward genetic technologies. The selection of personal values is an important part of consumer attitudes. Although the relationships between attitudes toward GM products and moral considerations as well as religiousness are varying in the results of these studies, those analyses that take into consideration the aspects of equity, conservatism, environmental responsibility, and material aspects include interesting details. In the results provided by Dreezens and associates (2005), the explanatory factor has become power/influence and universalism. According to their results, in regard to the negative feelings toward genetically modified foods, the difference between the respondents can be found in the fact that they have different notions concerning the relationship between man and the natural environment. GM foods seem to be the least negative for those who stress man's dominant role, while those who do not agree with this dominant role generally prefer to choose GM free bio-products. In regard to the individual values of consumers, it is also important to stress that, on the basis of survey conducted in Europe and America, Costa Font et al. (2008) found the following consumer groups: (i) those opposed to biotechnology, who have expressed their fears regarding both nature and technology and who have been labelled post-materialist consumers, and (ii) those consumers who are optimistic towards biotechnology and who are considered to be more materialistic. In summary, the authors have come to the conclusion that the perception of benefits and risks is essentially defined by the personal values of the consumer; the more determined and stable this system of values is, the stronger the effect they have on the consumer's attitude. Thus they have concluded in regard to knowledge and the handing over of information that the less important the role of values is, the more important the effect and role of new information is in the development of consumer perception.

- **individual knowledge**

A portion of studies have shown a direct and positive relationship between the increase in knowledge and the increase in support of GM foods. The relationship between more knowledge and better acceptance is also substantiated by the fact that professionals see less or different risks than consumers. Numerous researchers differentiate between objective knowledge ("the actual knowledge of the consumer") and subjective knowledge (what the consumer thinks he knows about GM foods"). This latter is n close relation to individual values and on the basis of those means a developed knowledge. Of the two, the latter has a greater affect on the consumer's attitude and is what can be brought into correlation with the acceptance of GM foods. In the case of those consumers who have a large amount of subjective knowledge at their disposal, new information does not have an affect regardless of whether the displayed attitude is supportive or rejecting. The provision of new information only has an affect on the consume attitude if the given consumer has not yet made a decision and do not have a developed stance regarding GM foods. (Costa-Font et al., 2008). The role of knowledge and scientific education in the GM debate is placed in new and very prominent light by the studies of Hornig Priest and co-authors (2003), among others. Numerous studies reflect the viewpoint that the spreading of scientific education

and the unilateral communications of science toward society can have the effect of winning over the dominant attitudes of the public towards the positive acceptance of agricultural biotechnology. Therefore the problem is a lack of knowledge and the lack of understanding of science on behalf of consumers; this should be abolished and we could immediately experience a beneficial change in attitude. However, the authors point out that the attitudes of the general public are not influenced by a lack of knowledge or more and better knowledge, but the trust or distrust in the institute of science. As they phrase it, the perception that the public has of transparency and the trust they have towards institutions (state, business sphere, science, non-governmental organizations) is a much better prognosis of the support that agricultural biotechnology receives than the actual knowledge concerning this technology and its scientific basics (Hornig Priest et al., 2003, pg. 751). More thorough scientific knowledge does not lead to a higher degree of support and ignorance from a scientific point of view does not undermine positive evaluation (pg. 765). On the basis of their empirical research, they set forth their "trust gap" hypothesis, with which they aim to signify that a much better prognosis of the differences experienced in the consumers of the given countries are the amount of trust the y put in certain institutions, which is a culture specific variant (pg. 752). It is thus very important to view public opinion not simply as a passive party of acceptance of information, but as an individual and community that actively search for and evaluate the trustworthiness of arguments that are in dispute with each other; their judgement is in large part influenced by the credibility of the individual sources (pgs. 765-766). Lassen and Jamison (2006) state that the developers and decision makers in politics would have a much clearer picture of and would be much better at understanding public opinion and the complexity of the attitudes of the layman if they would devote more attention to those categories and the language with which laymen understand and associate the GM dispute (pg. 27). As one of the principle results of their qualitative (focus group) survey conducted among Swiss consumers, Bonfadelli and co-authors (2002) indicate that the general opposing attitude towards industrialized agriculture is behind the opposition towards agricultural biotechnology (pg. 127).

A long line of studies have come to the conclusion that consumers are willing to pay higher prices for GM free products, meaning they attribute higher values to GM free products than to those foods that contain GM components. (According to studies performed in the United States, customers are willing to pay 5-17 % more for GM free potatoes, 5-62 % more for vegetable oil, 14-40 % more for maize flakes, 28-96 % more for morning cereals, and d0-110 % more for beef. In the case of rice, consumers perceive GM advantages and would be willing to pay 19-38 % more for the GM variety.) According to studies, consumers would pay a significantly higher price if they could be sure that they could avoid GM contamination. In the case of numerous products, for example potatoes, chips, breakfast cereals, milk, milk chocolate, maize, and tortilla chips, these studies have indicated that there are substantial GM free niche markets in the United States. The results of comparative analyses show that European consumers are willing to pay a higher price that North Americans and the demand for GM free products is also higher than for example in the United States. (Costa-Font et al., 2008)

### 3.3.2. Consumption research in Hungary

#### 3.3.2.1. Focus group and telephone survey analysis: D&T Marketing Research and Consultancy Offices [D&T Marketing Kutató és Tanácsadó Iroda], 2000, 2001

At the commission of Aventis Crop Science Hungary, D&T Marketing completed six focus group discussions in October 2000 and a telephone survey on 200 people in the fall of 2001, both of them in Hungary. The purpose of the survey is summarized by D&T Marketing in the following:

- “acquiring knowledge concerning the level of knowledge the Hungarian society has about biotechnological applications;

- shedding light on their disposition towards transgene basic materials and products, the acceptance of GMO plants, and the related attitudes;

- determine the scope of required information and the required method of dissemination of information;

- form a basis for and support the dissemination of information among society, including their "training" and positive influencing;

- lay the foundations for further areas of research" (D&T, 2000, pg. 4.)

The focus group discussions were initiated with the topic of "diet and health" and also included the topic of organic farming, which the researchers named as "bioplants." According to the participants, bioplants are "practically synonymous with good health" (D&T, 2000, pg. 10). In one group the issue of agricultural biotechnology spontaneously came up on the basis of the above; the moderator had to introduce this topic in the five other groups.

The 2000 research showed that genetic modifications were familiar to all participants and was an issue that all of them had heard of. The marketing research company performing the survey characterized the knowledge of the participants as having "partial information regarding genetic modifications and the suppositions and incorrect knowledge derived from those are determining" (D&T, 2000, pg. 12), which they felt was further substantiated by the telephone survey (D&T, 2001, pg. 4).

On the basis of the focus groups, D&T arrived at the result that duplicity can be experienced regarding genetic modifications. On the one hand, a separate topic is made up of the actual process of the genetic modification, and one consists of the results of the genetic modification, that is the plant that is the end result and the food product prepared from it. The first is unequivocally regarded in a negative light, participants regularly referred to the process as genetic manipulation. The latter, the result of the process is viewed somewhat differently: many are curious concerning the product and would willingly try it.

They consider genetic modifications, similarly to biotechnological procedures, to be a more scientific procedure than plant breeding and this in itself sparks doubts in consumers. A part of the reservations concerning the technology is rooted in the short history of genetic technologies: "…it has no past. This is a totally new thing, even scientists do not know what to expect" (D&T, 2000, pg. 14). They also feel that the process is "an interference into nature," which "cannot be performed without punishment" and that this will definitely "strike back" in the future (ib.). This fear applies to plants, animals, the natural environment, and human health. Although the resistance of plants and environmental protection also came up, in the background of genetic modifications, consumers see "mainly money and profits," where "the goal is increasing saleability," meaning the reasons for the technology are mostly economical (D&T, 2000, pg. 16).

Regarding the end product of biotechnology, the members of the focus groups stressed that it is important for the product's label to indicate if was made of genetically modified plants. It was emphasized that: the customer should be given the opportunity of making the choice when making the purchase. To the question of whether they would buy preserves, frozen vegetables, sauce, or other basic material from plants such as these, the survey reported that the members of the focus group showed a high degree of willingness to try. In fact, this willingness was so high "that even those who totally opposed genetic modifications as a process would taste or try these products" (D&T, 2000, pg. 17). The quotes listed in the summary of the report truly show curiousness and a willingness to try these products as well as an openness and a lack of fear on behalf of those

making the statements. However, these quotes also contain references to the fact that they would have reservations when trying the products; although they are not scared, since genetic modification and supporting the technology with their purchase is against their values, they would require "more information" concerning the topic. In the second round of the survey, more than half of those who responded over the telephone would try GM food products, while 25 per cent would definitely not try them, and a further 21 percent would probably not try those (D&T, 2001 pg. 10).

In this context, D&T also stresses that the consumer decision would be preceded by a test. The consumers would prefer to be sure that these foods do taste good. On the basis of these answers, D&T assumes that the consumers feel that "although genetically modified plants and the foods prepared from those are pleasing to look at and big, they are not tasty to eat, they have no taste, taste very bad, or do not taste the same (D&T, 2000, pg. 18).

The other determining condition of buying and buying again is price. "This may be the only instance in which GMO is related in some was in people's thoughts to healthy eating. Bioplants and healthy eating are considered to be an 'expensive whim'" (D&T, 2000, pg. 18). Thus, according to the assumptions of consumers, GM foods will be more expensive that non-GM products, determines the study.

At the same time however, D&T has drawn the following conclusions from the negative was genetic modifications are viewed and from the fact that the respondents rely on partial information: " … according to this viewpoint, genetic modifications and the positive environmental effects that take place as a result of and the healthy plants that are a result of this technology are not linked to healthy eating and environmental protection" (D&T, 2000, pg. 12).

During the course of the survey, the participants were also asked whether they considered genetic modifications to be useful. The answers showed a great degree of variance: a total of 42 per cent does not hold them to be useful while almost the same percentage (43 per cent) holds the technology to be useful or very useful (D&T, 2001, pg. 5). Consumers from small towns seem to show the most opposition, however there is no "pugnacious opposition" (Pádár, 2002). According to D&T's conclusion, "there is no unequivocal restraint regarding foods prepared from genetically modified plants," „consumers can be won over".

On the basis of all of the above, the marketing research company has made the following suggestion to the customer: the provision of information is necessary and those arguments must be used through that process "which people 'have ears for'" and what "they wish to hear." Such arguments are, for instance:

- attention arousing and convincing;
- stress the safety of the applications and the fact that it poses no threat to man or the environment;
- approach the topic from the angle of health and "spread the information that these are not chemicals or preservatives";
- demonstrate that genetic modifications "will not cause damages, sicknesses, or alterations in the future, either";
- are about the "beneficial effect" they have on health (D&T, 2000, pg. 19);

- "in order to clarify the past," they summarize the past and development of genetic technologies (D&T, 2001, pg. 4).

### 3.3.2.2. Survey: Central Food Research Institute [Központi Élelmiszerkutató Intézet], Szent István University, 2001

The Central Food Research Institute (KÉKI) and the Food Economics Department of Szent István University (presently called Corvinus University of Budapest) has provided numerous results. One of the main messages of these results is that the Hungarian consumer, despite the fact that he has heard of genetic modifications, is basically not in possession of the necessary information, "is not properly familiar with the results of genetic technologies…, presumes assumed or true negative aspects, or is at least suspicious of genetic modifications" (Lakner et al., 2003, pg. 129). "Many consumers have no idea what biotechnology is about; two thirds of all consumers think that ecological production, since it is referred to as bio-production in Hungarian, is a part of biotechnology. Only 55 per cent of the respondents is clear on the fact that biotechnology and genetic modification are similar terms (Bánáti–Lakner, as quoted by Bánáti, 2008, pg. 442). Consumers are becoming more knowledgeable, but they are characterized by a lack of knowledge concerning molecular biology (Bánáti, 2005).

The researchers had surveys filled out by a group of 1000 people to examine their knowledge and perceptions. 84 per cent of the respondents "had heard of the fact that the hereditary material (genes) of certain micro organisms, plants, and animals are being modified through human intervention" (Lakner et al., 2003, pg. 128). The results showed no difference between the genders but significant variances between age groups. The age group of 25-39 year olds is the most informed.

Practically all those with university diplomas have heard of genetic technologies while 94 per cent of high school graduates, 80 per cent of trade school graduates, 67 per cent of grade school graduates, and 47 per cent of those who did not even finish grade school (mostly those older than 60 years of age) belong to this group.

The study also researched whether "the general public is aware that the foods they consume can by produced from basic materials which contain genetically modified organisms" (Lakner et al., 2003, pg. 128). 18 per cent of respondents believe there are no genetically modified foods in Hungary, 46 per cent feels it is possible that the foods they consume also contain genetically modified materials, and a further third is not sure and has no knowledge of consuming such products.

Regarding the provision of information to consumers, 90 per cent feels it necessary to indicate on the package if the product contains genetically modified components.

Regarding the usefulness of genetic technology, a fifth of the respondents stated that they hold the new technology to be useful, but only 2 percentage points considered it to be very useful. On the other hand, 56 per cent feels that it is harmful, of which 30 per cent deems the technology to be very harmful. When the question was aimed directly at the usefulness of the technology according to the goals of genetic technologies, they arrived at the following results:

- enhancement of taste – close to 60 per cent,
- decreasing the use of plant protection products – close to 50 per cent,
- larger yield – close to 60 per cent,

- smaller fat content – 55 per cent feel the goal is useful.

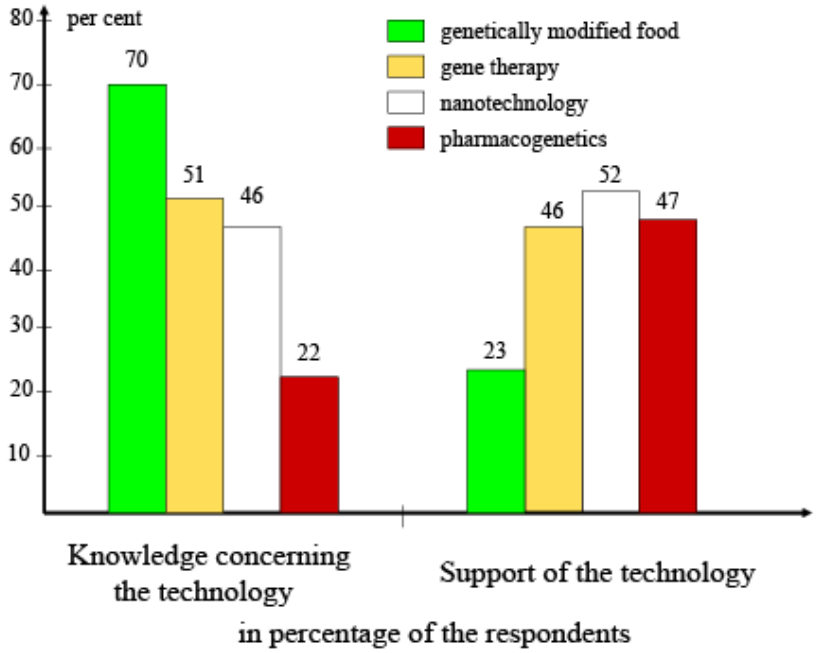
Of the basic for and against arguments, the respondents in this survey opted for the one (with an average value of 4.34 on a scale of 5) that stated that "nature is altered through the modification of genes, and we cannot know the consequences beforehand" (Lakner et al., 2003, pg. 129). A further two arguments that embodied the negative aspects of genetic technologies (man interferes in the job of the Creator, and genetic modifications can be detrimental to the health of consumers) follow with a value of around 3.6 Of the arguments for genetic technologies (increased yields that help combat hunger and better product quality) both received a value of around 2.8-2.9.

### 3.3.2.3. Eurobarometer: "Europeans and Biotechnology, 2005: patterns and trends"

During the year 2005, a research by survey was conducted for the 6$^{th}$ time in the European Union concerning the issue of biotechnology. The first survey took place in 1991, which was followed by new research every three years. Following Hungary's accession to the EU, the country was first included in the sample in 2005. At that time, similarly to the other 24 Member States, 1000 local citizens were queried. The study included biotechnology on the one hand, and, on the other hand, four concrete areas of technology, research, and utilizations, which are the following: genetically modified foods, nanotechnology, gene therapy, and pharmacogenetics. We present here the data relevant to Hungary. Of the four technologies, this summary concentrates on genetically modified foods and plants and will only provide a brief overview of the study results concerning the other biotechnological fields.

70 per cent of Hungarian respondents new what genetically modified foods are (this is the best known technology of the four technologies included in the survey). This knowledge is somewhat below the EU average. It is 10 points lower than the average attained in the EU25 concerning GM foods. However, this indicator varies on a very large scale in the individual countries, from 52 (in Latvia) to 92 per cent (United Kingdom). There are six countries in all in the European Union where a smaller percentage of respondents had heard of genetically mediated foods than Hungarians.

*Figure 6* *Biotechnology according to Hungarian respondents*




**Source: Gaskell et al. (2006): on the basis of 16 and 19**

Less than one fourth of Hungarian respondents is supportive of GM foods and more than three quarters is opposed. Of the four technologies listed above, this is the one against which the most people are opposed: all three of the other technologies are supported by at least twice the number of people. A similar degree of opposition can be encountered in the countries of Poland and Lithuania. A further 10 countries in the EU show an even smaller degree of support for GM foods (the most opposition is found in Luxembourg and Greece) and 12 countries are more optimistic towards GM technology.

The most support, 46 per cent, is given in the Czech Republic, which figure qualifies the country as exceptional for two reasons. For one, because the ratio of Czechs that support GM foods is exceptionally high even compared to the next country in the ranking (Portugal with 38 per cent), and also because the other newly acceding EU states reside in the second half of this EU-wide list, meaning they are generally less optimistic and show less acceptance regarding this new technology. It is also important to note that the EU average of support does not surpass the Hungarian average by far as it is only 27 per cent. The authors of the Eurobarometer survey especially stress that even the support the technology receives in Spain (where genetically modified crops are grown on several ten thousand hectares) is only 7 per cent higher than this low EU average (Gaskell et al., 2006, pg. 19).

Regarding all the related questions, 63 per cent of those who gave worthy answers besides "I don't know" are opposed to GM foods. The remaining 37 per cent are supportive; this percentage includes those who are supportive of GM foods but deem those to be risky (Gaskell et al., 2006. pg. 21).

The willingness to purchase GM foods was studied by Eurobarometer by stating five questions that concerned whether the respondent "would purchase genetically modified foods if

- they were healthier than other foods;

- they contained smaller amounts of residual plant protection products than other foods;
- they were produced in am or environmentally friendly manner than other foods;
- the proper authorities approved or authorized their production;
- they were less expensive than other foods."

Close to 45 per cent of Hungarian respondents answered no to all five arguments, while the rest of the respondents felt that 3-3.5 of the above arguments would influence their purchase decision (Gaskell et al., 2006, pgs. 22-23) .

It is worth mentioning the data of another area of the survey that dealt with industrial biotechnology, as this concerns those genetically modified plants that are the inputs of not the food industry, but of fuel production, the plastic industry, or the pharmaceutical industry. Answers that concern only Hungary are only available for this last question and are special from the point of view that the question also included the information that these plants are grown in greenhouses, meaning they are in an enclosed area. 12 per cent of the Hungarian respondents would not allow this under any circumstances; 22 per cent feels that such production should only be allowed if special circumstances were to arise; 37 per cent says that the production should only be allowed if the area is stringently controlled; 14 per cent feels that production is acceptable with the presently relevant governmental regulations and legislation (Gaskell et al., 2006, pg. 27).

Eurobarometer also included the issue of how (through professional scientists or the general public) and what factors (scientific proofs or moral arguments) should control biotechnology and found a basis for the making of decisions. Compared to other EU countries, Hungary (along with Lithuania) has the highest ratio (72 per cent) of respondents who would have the technology controlled by professional recommendations and the proof of scientific benefits and risks. A further 13 per cent would also entrust professional scientists with the decision but would lay emphasis on moral factors. The remaining portion of the respondents (14 per cent) would give the general public control over biotechnology instead of scientists; the majority of these (10 per cent) rely on moral factors (Gaskell et al., 2006, pg. 45).

More than 90 per cent of those Hungarians who took the survey trust university researchers and 80 per cent trust the researchers and scientists working in the biotechnological industry. 75 per cent also trust the industry itself. 83 per cent trusts governmental regulations while a higher percentage, 89 per cent, trusts the regulations of the EU that pertain to the control of biotechnology (Gaskell et al, 2006, pg. 51).

### 3.3.2.4. Focus Group Study: Corvinus University of Budapest, 2006

With the implementation of two focus groups, the OTKA research project numbered F 046947 with the title "The legitimatization strategies of agricultural biotechnology companies" („Az agrárbiotechnológiai társaságok legitimációs stratégiái") wished to shed light on the sources from which consumers acquired their knowledge, information, and opinions regarding agricultural biotechnology and how these sources shape their opinions. The members of the focus groups were Hungarian citizens with high school or university diplomas.

Both focus groups showed that participants know what genetic modification is and some had not only rudimentary knowledge but also knew and could relate details, such as the toxin production of genetically modified plants or the development in Hungarian policy that was still fresh at the time, the safeguard clause. The experience of the two focus groups shows that consumers are relatively well informed, they acquire their knowledge primarily from published and electronic medias, which include sources such as environmental protection webpages, economic weekly magazines, and nature films. The participants divulged their opinions in detail and with a high degree of complexity.

The associations regarding foods that include genetically modified basic materials were negative in both of the focus groups regarding

- risks (I am scared of it, they are pleasing, but why?; they are hazardous; the long term effects are unknown);
- this also especially included health risks (unhealthy; detrimental to health; diarrhoea);
- the future (unstoppable);
- the approach shown by consumers (refraining, distrust);
- the quality of the product (mass produced, uniform, global production, sham, not real, but the dimmed down version of the original);
- the method of production (unnatural, interference with nature).

A deciding factor on the consumer side is that they feel "GMO = scam." It looks like the nicest of traditional foods (vegetables, fruits) and may even be cheaper. The technology thus contributes to those processes that already characterize the available food selection (wide variety of products, better availability of certain foods such as exotic foods, but decreasing levels of quality safety, continuousness, traditional tastes, a lack of seasonality). Due to the fact that GMOs are actually a scam, it is not in the interest of the producer to provide information and spread knowledge.

Despite the fact that the consumers were questioned on the basis of their food purchases and consumption, the respondents identify as the primary problem that it is an "intervention into the order of nature that has not been properly assessed and the results are thus unknown." The respondents drew several comparisons with developments and innovations that have been found

to be harmful or deadly (DDT, Contergan) and also stressed that catastrophes happen even though regulations concerning the pharmaceutical industry are extremely stringent and circumspect. The range of consumers that are affected by the given products of the pharmaceutical industry is rather small, while GMOS are "worse, since they affect everybody." At the same time, the argument that "developments must move on" also arose.

Participants decidedly held the safeguard clause to be a positive step and noted that it should be maintained for as long as possible. The opinion that Hungarian farmers could be easily persuaded to grow GMOs has developed since they would probably be sold seeds at a very competitive price. The reasons for upholding the safeguard clause included the fact that the consequences of GMOs, either as plants or as foods, are as yet unknown and experimenting would be "playing around with life" and people do not want "experiments to be conducted on us." Therefore they should only be studied for the time being and the focus should be the evaluation of their effects, but they should not be distributed yet.

During the focus groups, the participants were asked to evaluate the statements of definitive domestic GMO players (authorities, researchers, non governmental organizations) without the respondents knowing who the statement originated from. On the basis of the replies, it seems the Ministry of Agriculture and Rural Development is credible; Greenpeace was also found to be straightforward, while the phrases representing Syngenta and Monsanto were deemed definitively untrustworthy, and the quoted plant genetics researchers were also found to be partial and unequivocally pro GMO.

### 3.3.3. Conclusions drawn from the consumer surveys

The main conclusion of international and domestic consumer studies is that the majority of European and Hungarian consumers are disinclined to accept agricultural biotechnology. Domestic consumers are especially negative towards agricultural GM products even in a European comparison, and they also have strong negative associations linked to GM products.

The majority of European and Hungarian consumers therefore supported the safeguard clause on GM products and felt it to be necessary. It appears from the qualitative analysis of both the domestic and European consumer opinions and attitudes that, despite the arguments presented by the supporters of GMO, consumers feel that the introduction of GM products is mostly spurred by business interests and they fail to see, or rather miss, those societal gains that are manifest on a wider scale. It is especially worthy to note that the qualitative studies also indicate that consumers evaluate GM products not solely from the aspect of their own or other's economic benefits but also seek for benefits for the community and society; failing to find these, their opposing stance is strengthened. As opposed to the medical applications of biotechnology (which are again not perceived as risk free), the "results" of agricultural biotechnology are unequivocally listed in the category of private profit and societal benefits are found to be lacking.

Consumer surveys also indicate that personal values also have a strong influence on the attitude displayed towards GM products. Namely, the orientation of values according to which GM crops and foods include an undesirable intervention into nature and which sees the process as a vain attempt to gain unnatural control over nature is characteristic of unsympathetic consumers. The basis of the opposition in a part of consumers and the public opinion is this value system.

It is also an important result from an economic aspect that according to these studies, the majority of consumers would be willing to pay more for GM free products and foods than those that include GM ingredients. Thus, from the point of view of the price and on the basis of the present consumer preferences, the maintenance of freedom from GM products can be more alluring from the angle of food supply.

Both Hungarian and international studies have reached varying results regarding the knowledge of consumers and how informed they are. Numerous data and findings show that consumers are not familiar with the details of genetic modifications and they freely associate these processes with other things that seem similarly mystical and unknown. However, certain available information also shows that people understand the basics of the technology, are open to the relevant information, and in fact are interested and follow the developments and examples of the field. The interesting question is the interpretation of these data, which raises the question of whether it is justifiable to expect consumers to have this knowledge, and, if yes, to what extent?! However, several studies also show that it is not the knowledge or the lack of that is a good indication of the consumer's attitude toward GMOs, but rather the trust they show towards the institutions and the institutional system. The strategy that blames consumers for their low level of scientific knowledge or that sees the solution for the spreading of GM products in disseminating information to the general public does not seem to be viable. According to the results of these studies, the degree and extent of trust displayed towards science, the regulating authorities, the business world, and non-governmental organisations (NGOs) holds a more important explanation in any given society. It is the failing and decrease of this trust in Europe, especially the lack of trust towards science, regulating authorities, and the business world, as well as the discredit these institutions have, that is the essence of the problem. It is worthwhile to quote the conclusion of Brian Wynne, a famous British risk assessment scientist, which conclusion he drew on the basis of a research program that took place in five European countries:

> "The root of the conflict does not lie in the technology but in the way institutions handle these issues. Rather than denying uncertainties and framing the issue as conflict between promising market opportunities and overcoming public irrationality, institutional decisions makers are well advised to reflect the potential social benefits of this technology and to provide sufficient room for an extended and open societal dialogue about the orientation of scientific research." (PABE, 2002, pg. 2)

# 4. Other economic analyses and lessons

## *4.1. Macroeconomic analyses and conclusions*

We have thus far introduced the economic effects and experiences of agricultural biotechnology by heading along the food supply chain from the point of view of the major market players. The question of whether we know anything of the actual and/or potential macroeconomic effects of agricultural biotechnology is justified. We therefore present a number of those economic studies that have dealt with the effects of agricultural biotechnology on the level of the national economy. This summary can obviously not even strive to be comprehensive and to analyse all the available scientific publications. We concentrated mainly on the most recent issues of two scientific publications. These publications are the *American Journal of Agricultural Economics* and *Food Policy*.

Economic models are characteristically based on partial equilibrium, general equilibrium, and international commercial models in order to asses the effects of agricultural biotechnology on well being at the level of the national economy. These models are therefore primarily built upon the implements of dominant neoclassical economics and thus inherently include, besides their advantages, all their restrictions. One of the main restrictions of these models is that they are static, meaning they evaluate the changes in economic well being on the basis of "standing pictures" and are not capable of thinking in a dynamically changing system of presumptions (economic variables). This results in the fact that what could be statically true in the analyses of certain GM products and their effects does not necessarily stand its ground in other situations or

variant systems, not to mention the dynamically changing competition requirements in the global economy. However, the static wellbeing analyses of the models are also capable of presenting interesting results, can raise further questions, and can also shed light on certain unfounded illusions.

Sobolevsky and co-authors (2005) conducted their analysis in an international commercial partial equilibrium model encompassing four regions, on the commercial effects and the effects on well being of the introduction and spreading of GM soybean.[6] Their model included differentiated demand (that is both with GM soybean demand and demand for GM free soybean) in the part of the world deemed by them as the fourth region and also calculated the costs of segregation that thus arose. If segregation were not possible, their model shows that the whole world would produce only GM soybean, and this would increase the well being of the four regions because of the fall of soybean and soybean product prices. It is interesting that although the United States would maintain its leading soybean production and soybean exporting position, the well being of American farmers would decrease. It can be concluded on the basis of the results of the model that there would be no opportunity for the production of GM-free soybean and this would obviously limit the choice farmers and consumers would have. This does not figure in the model as a decrease in well being, as the model only includes those effects that can be well expressed in pecuniary terms. Besides the numerous analyses, one of the many interesting results of the model is that if Brazil and the rest of the world were to ban the production of GM soybean (which is not far from the present state) and if the costs of segregation are not negligible (which also seems to be a realistic assumption), then the rest of the world would achieve a definitive increase in well being compared to the situation of not implementing a moratorium. At the same time, if the rest of the world were to introduce a ban on GM soybean import, all regions would fare worse, meaning it would result in a decrease in well being.

Fulton and Giannakas (2004) aim at inspecting the effects the production and entry into the food supply chain of GM plants has if labelling is necessary, as well as if labelling is not necessary, and how all this correlates in terms of well being to the situation when there are no GM plants at all (for example, because those have been banned). An important and lifelike supposition they make is that consumer are not homogenous, meaning certain consumers accept GM products and certain consumers oppose GM products. Their model also hypothesizes that farmers are heterogeneous. The main finding of their analysis is that the interests of consumers, farmers, and agricultural biotechnology companies will differ and will thus come into conflict. With the introduction of GM plants, the well being of consumers decreases significantly if the opposition against GM products remains strong and the costs of segregation remain high. Farmers (producers) can also experience negative effects with the introduction of GM plants due to the widespread opposing behaviour of consumers and the high price premium of seed producing agricultural biotechnology companies. Due to these varying results, the authors came to the conclusion that consumers, farmers, and agricultural biotechnology companies will prefer different labelling solutions, and there will hardly be a system that corresponds to all their preferences. Labelling is therefore decidedly a normative, political issue which is decided in the strife of interests of the various groups on the basis of their political influence. Lapan and Moschini (2007) also support this latter statement and also came to similar conclusions through a different approach: if there is no labelling, that will lead to a decrease in well being; if the obligations regarding labelling are too strict, GM free products can be ousted, also leading to a decrease in well being.

The analysis conducted by Lapan and Moschini (2004) is especially important because they take into account market failure as an endogenous factor in their partial equilibrium model for two countries. This is because in economic theory, GM products have a negative external (economic)

[6] The four regions are the United States, Argentina, Brazil, and the rest of the world. This classification was obviously justified by the roles in soybean production and export of these three countries.

effect on non GM products. Eliminating the effects of GM products causes added costs on non GM producers, distributors, and consumers. The final conclusion of their report states that the introduction of GM products decreases well being if producers have to bear the costs of the negative external effect that arises as a result of origin certification. According to the model, importing countries where consumers prefer GM free products experiences losses in well being.

The analysis of Mayer and Furtan (1999) is more concrete than the reports introduced thus far, as it analyses the economic effects of GM rapeseed production in the prairie regions of western Canada. Utilizing the customary positive assumptions, the authors found concerning the production cost decreasing effect of GM rapeseed that the farmer surplus can increase with the production of GM rapeseed, meaning western Canadians are in for a profit. However, their income is relative to the costs of segregation. If GM rapeseed and non GM rapeseed are not segregated from each other, or if only GM rapeseed is being produced, the Canadian farmers will be devoid of an important export market due to the preferences of consumers for non GMO products. This means that the western Canadian producers of GM rapeseed can only experiencing advantages with the introduction of GM plants if the consumers on their important export markets trust in the origin of the purchased products (meaning they are clear on whether the product is GM or non GM).

Berwald and co-authors (2006) as well as Johnson and co-authors (2005) examined the consequences of the possible introduction of herbicide resistant GM wheat and arrived at significantly different conclusions. Monsanto developed a RR wheat variety and planned its introduction on the North American market only if both the United States and Canada authorize its commercial distribution. The new GM variety passed through the regulating system of the United States with relative ease, as it was authorized as a product of substantial equivalence. However, the seed law relevant in Canada is more complex and applies several regulatory procedures of those concerned (including among others the Canadian wheat buyers) for the approval of new wheat varieties. The Canadian procedure did not bring favourable results for Monsanto and the new GM variety did not receive the authorization for commercial distribution. The company therefore totally gave up on its introduction. The analysis of Berwald et al. (2006) shows that North America in its entirety lost economic profits by avoiding the production of RR wheat. However, Johnson et al. (2005) conducted a study regarding the United States and showed that the main export markets of wheat included some that are opposed to GM plants. In order to avoid the loss of the export markets, a double supply chain must be established for wheat that guarantees that the segregation and identity preservation of GM and non GM wheat is transparent and can be tracked. This process can result in costs that make the introduction of GM wheat economically unfeasible. Berwald et al. (2006) considers these very segregation costs to be negligibly small, thus leading to the contrary final conclusion of the two studies.

Wilkinson (2005) compared the competitiveness of the Brazilian export market with that of Argentina and the United States in the second half of the 1990's, when the production of GM plants was widespread in the latter two countries. In the 1970's, the United States offered close to 80 per cent of the world's soybean commerce. This then changed with Argentina and Brazil gaining input. Despite the fact that area on which soybean was produced in the United States grew, by the second half of the 1990's the country lost its prominent role in the international soybean industry. Soybean is the second most important crop in the United States in regard to area of production; 40 per cent of the total production is exported. State subsidies only led to increases in the area on which soybean is grown and did not help the competitiveness of American soybean production, which was gradually decreasing. The production yields are only slightly higher than those in Argentina and are lower than Brazil's (pg. 3). The soybean market became segmented: demand for GM and non GM soybean has become separated. Besides the EU, numerous Asian countries (Japan, South Korea, Thailand, Indonesia, Hong Kong, and China), Australia, and New Zealand introduced compulsory labelling for GM pants. Farmers receive higher prices for non GM soybean (pg. 8). The international market loss of the United States coincides with the consumers of many countries opposing GM plants. The United States experienced the same process with maize, as numerous countries, including Brazil, enjoyed the economic advantages of the fact that GM maize was not received in a number of important export markets. Both Japan and Iran prefer Brazilian non GM maize over the American GM maize (pg. 9). According to the

author, it is economically advantageous for Brazil to remain GM free until the technical and institutional requisites of segregation and identity preservation are implemented, since the country could and/or maintain increase its international export markets to the debit of GM producers until a significant amount of consumers oppose the consuming of GM products and thus create a market for GM free plants (pg. 10).

Turka and Vanags (2008) examined the possible production of GM rapeseed in Latvia. According to their findings, of the available GM crops (for example, there is no need for Bt maize, since maize does not have any pests in Latvia), only HT rapeseed and maize offer opportunities for production in Latvia. At the same time, the risk in the case of HT rapeseed is high that insect and wind pollination will cause the plant to spread to wild varieties as well as to farms producing non GM and bio varieties. Therefore the adherence to coexistence regulations will foreseeably burden producers with high costs. Conventional varieties contaminated with GM rapeseed can only be sold as biofuel, thus resulting in losses for producers. The authors calculate with a 30 % drop in income (pg. 218). Latvian honey producers will also experience external negative effects, say scientific estimates, to a degree of a drop in prices of 50%, since consumers are only willing to pay smaller amounts for GM contaminated honey. In all, the authors come to the conclusion that the production of GM rapeseed would, in the present situation, result in losses for Latvian producers (pg. 219), and therefore would not be economically rational.

Although Moschine and colleagues (2008) do not model the direct market effects of GM crops, they deal with an issue that could have important lessons in the debate focusing on GMOs. The authors examine the market effects of labelling the geographical source. The labelling of geographical source is actually one of the alternatives of state labelling, since it relies on the cooperation of producers to develop a brand logo. For consumers, geographical source labelling is a guarantee for a quality characteristic of the product and this contains valuable information. The labelling of the geographical source, as a form of intellectual property, is acknowledged by the World Trade Organization (WTO) in its council on trade-related aspects of intellectual property rights (TRIPS). The EU acknowledges two types of labelling of geographical source, Protected Designations of Origin (PDO) and Protected Geographical Indications (PGI). The PDO includes more stringent requirements than the PGI in that the former sets forth that the whole process of production is to take place on the given region, since the characteristics of the product are only then manifest solely through the human and natural environmental aspects of the given geographical region. In the case of the PGI, it is sufficient if a part of the product characteristics and the production process can be linked to the given region. There are presently more than 700 registered PDO and PGI products in the EU, the majority of which have been registered by the producers of five southern European Member States (France, Greece, Italy, Portugal, and Spain). The analysis of Moschini et al. (2008) provides the argument that the net competitive market does not have the necessary supply of high quality products with labelled origins, therefore the provision of state subsidy of origin labelling increases the well being of consumers and eliminates market failure. The analysis can also draw attention to some especially important aspects regarding coexistence. We thus continue with this topic.

## *4.2. The economic aspects of coexistence*

When examining the food supply chain, we mentioned that the roles of quality and safety have increased. The majority of consumers are sceptical concerning or opposed to GM products, as these products increase a feeling of insecurity, arouse fears, and thus consumers would only purchase these products, if at all, if they were substantially less expensive. In fact, 174 regions and more than 4500 settlements have declared themselves GM free in the EU and have obligated themselves to maintain this status (see: http://www.gmofree-europe.org). All the above shows that segregation and identity preservation remain an important factor on a market with segmented

demands. On behalf of the producers, the possibilities of coexistence of the various production systems (including everything from conventional agricultural techniques and the various forms of ecological farming to farming using agricultural biotechnology) have to be reckoned with. Thus, on the one hand the legislative background of coexistence aims to maintain the opportunity of farmers to make their own choices. On the other hand, the legal regulation of coexistence is also economically substantiated since the production of GM crops and their inclusion into the food supply chain can have negative external effects. Previous economic studies have also shown that if the seeds and yield of conventional agriculture, but especially ecological farming, are contaminated by GM plants, the non GM farmers experience serious economic damages. They can lose the markets where they sold their products at a price premium exactly because of their freedom from GM. Since agricultural practices do not take place in a closed system, proper techniques and organizational measures must be taken in the phases of production, harvesting, storage, and transport in order to maintain the systems of segregation and origin labelling and to ensure that those inspire confidence and trust in the end consumers regarding the safety of the products to be consumed. It is thus worthwhile and necessary to include those well known analyses that deal with the possibilities and economic affects of coexistence.

On the basis of the model set up by Belcher and co-authors (2005), we call attention to the fact that coexistence can only be accomplished through very thorough and diligent spatial land use planning. The likelihood of GM contamination is a factor of the type of GM plant and agronomical practice. It is therefore not possible and not feasible to make general coexistence regulations that are applicable to all GM varieties and the all areas with their widely varying agro-ecological and socio-economical characteristics. In the case of those GM plants where the likelihood of cross pollination is especially high, Belcher et al. (2005) suggest precautionary steps and production on only small areas (pg. 397).

Munro (2008) points out the spatial externalities caused by GM varieties. The unregulated free market cannot maintain both the production of GM and non GM varieties; state regulations are unequivocally necessary due to the failure of the market. On the basis of the results provided by the simulation model, Munro stresses that if a farmer producing GM crops does not face any costs (for example, the liability insurance against GM contamination) then when he starts producing such a plant in an area that was previously GM free, the equilibrium between GM and non GM varieties will invariably remain unstable.

In the framework of an EU financed research project, Messean and co-authors (2006) simulated the possibilities of coexistence with gene flow models that also took into account the spatial characteristics of the landscape as well as agricultural practices. An important maize producing region of France called Poitou-Charentes posed the basis of their model. On the basis of the above, the authors drew several conclusions (Messean et al., 2006):

- In the case of farmers producing GM seeds, the additional costs can amount to 20 % of their gross profit, which arises from the adherence to coexistence regulations if the price of GM and non GM seeds is the same. The production of GM seeds is therefore economically not appealing.

- In the case of growing non-GM maize seed and GM maize together, significant changes would have to be made to the agricultural practices presently used; the most important factor is to increase isolation distances to 400-600 m.

- Further steps would have to be taken in maize production in the case of certain climatic, regional, and agronomical characteristics (the experiences of the French case study can not automatically be extended to other regions).

- However, adhering to the obligatory isolation distances does not have the same effects on farmers. Those farmers in the case of whom the neighbouring farms lie outside the isolation distance do not encounter any economic limitations when they choose between GM and non GM varieties. The costs of GM production determine the economic effects in the case of smaller farms.

Demont and co-authors (2008) compare two alternative regulatory solutions to the issue of spatial coexistence: the regulation of a strict isolation distance and the more lenient system of puffer zones that makes it possible for farmers to bargain between them. The authors start off from the supposition that the regulations of coexistence practically acknowledge the needs and desirable nature of the production of GM plants. Therefore those coexistence regulations that cause the producer to bear a relatively ("disproportionately") large part of the burden do not meet this connotation of coexistence. Their model simulates a hypothetical case and declares (concerning the production of rapeseed in central France) that a sort of "domino affect" become manifest in the regulation of the stringent isolation distance, which leads to increased economic burdens for GM producers. The authors are in favour of the regulation that enables the bargaining of GM and non GM producers, which should however be supplemented by strict ex post regulations on responsibility (pg. 688).

Menrad and Reitmeier (2008) examine the economic affects on the farmer of coexistence in the case of GM maize and with different coexistence regulations. Using the French Poitou-Charentes region as a basis (regarding intensive maize production), the authors find that the establishment of non GM puffer zones results in much higher costs than for example designating isolation distances. And an even more expensive solution is temporal rotation that is offsetting flowering periods (pgs. 110-111). Cost effectiveness thus substantiates the regulation of isolation distances. In the case of the coexistence of seed production, the authors calculate a very high additional cost. For example, in the case of a 0.5 % threshold, additional costs of 410 EUR/ha are incurred on an area of 0.5 ha, and this cost can rise above 650 EUR/ha if the threshold is more stringent (in the case of thresholds of 0.3 and 0.1 %, pgs. 111-112). In summary, the costs of coexistence can amount to 15% of the gross profit of farmers in the case of seed production in France under the studied circumstances (pg. 117). The regional affects were modelled on the small parcel maize producing farms of Bavaria. An interesting result they provide is that if GM crops spread to a relatively small degree, meaning that 10 % of farmers grow GM maize, the result is that 19-25 % of Bavarian farmers are affected by the problem of coexistence due to the problem of cross pollination. If 30 % of farmers grow GM crops, half of farmers are concerned (pg. 115). The authors point out as a great deficiency that we hardly know anything of the costs of liability insurance of coexistence and of the training and preparatory programs aimed at farmers (pg. 118).

Binimelis (2008) processes the coexistence experiences gained in Catalonia and Aragon. In the first cases of accidental mixing, when the farmers suffering the GM contamination initiated legal proceedings, the identification of the farmer guilty of the contamination immediately proved to be a problem. It is especially difficult to establish the cause and effect relationship (determining the identity of the contaminator) if GM production in the region is relatively high and farms are generally small in size (pg. 448). The author determinedly points out that basin the laws of

responsibility on the civil code narrows the problem down to a question of financial compensation and also "individualizes" the whole question, as it does not take into account the effects manifest on the societal and environmental context (pg. 452). According to Binimelis (2008), the decrease of ecological farming practices in Catalonia and Aragon is linked with the spreading of GM crops: the area on which bio-maize is grown in Aragon decreased by 75 % between the years 2004 and 2007 and by 5 % in Catalonia between 2002 and 2005 (pgs. 450-451). The author states that the relevant legislation and institutional environment supports the spread of agricultural biotechnology to the detriment of ecological farming (pg. 452).

In summary, it can be seen from the previous study that the issue of coexistence poses serious economical and societal questions in agricultural policies. It is clear that the production of GM crops thus cannot be considered as merely a decision to be made freely by the growers themselves in as much as it has negative external effects. It infringes upon the freedom of neighbouring growers to make their choice and upon their economic interests. The likelihood of cross pollination can cause damages within small economic frames to biological diversity that are difficult to handle both on the level of genetics and habitat. It is thus not clear what legislative frameworks should be used for the definition and management of all these potentially arising damages. The Environmental Liability Directive (Directive 2004/35/CE) very narrowly determines environmental damages and does not deal with the broader perspective of the maintenance of the biological diversity of agricultural areas. Neither do present national coexistence regulations look beyond economic losses, nor does the Civil Code seem suitable for the assertion of damages sustained beyond the limited realm of property and commerce that take place in the natural environment and biological diversity (Rodgers, 2007).

Agricultural policies will also always have to face serious economic and societal issues in case GM crops are put into production, since either decision will result in ecological and traditional growing practices to be either upheld or to disappear (Altieri, 2003; Garcia–Altieri, 2005; Ponti, 2005; Oguamanam, 2007). In the case of ecological farming, the tolerance level of GM contamination is zero. No product can be qualified as being organic (bio) and sold on the market as organic (bio) if it is not 100 % GM free. This could pose to be a severe economic loss to the growers of ecological products and also to those consumers who seek bio-produce. For example, the experience gained in Aragon and Catalonia referred to above (Binimelis, 2008) indicates that the organic farming of those plants that are also grown in a GM variant in the same region can be drastically reduced. Agricultural polity this has to face the fact that if the production of GM plants spreads in a given area (for example in the Carpathian Basin), certain forms of organic farming become impossible. And this is a severe market loss to both the growers of organic products and to the consumers of organic farming (to the latter because of the decreasing domestic supply, which leads to price increases and thus causes an unequivocal decrease in well being).

It is indisputable that the products of ecological farming al over the world, in Europe, and in Hungary are niche market products, but the future potential of the market does not seem to be at all negligible, especially considering the fact that consumer demand on the food market is characterized by growth in the areas of convenience foods and foods that aim at aiding a healthy diet (Wier–Calverley, 2002). This latter indicates a continuously growing market demand for the organic products originating from organic agricultural practices.[7] The global market of organic products increased by 12.8 % between 203 and 2007 and the same European market increased by 14.8 % (resulting in total revenues of 43.5 and 22.3 billion USD, respectively, in 2007). Prognoses still forecast double digit growth of 9 % and 10.6 %, respectively, for the period

[7] Füredíné Kovács and co-authors (2006) also relate concerning the market of bio products in Hungary that consumers hold bio foods to "have health maintaining effects as well as numerous physiological advantages" (pg. 4). However, domestic consumers preferred Hungarian bio products in both supermarkets and at ecological markets if those did not significantly differ in quality and price from imported bio products (pg. 7).

between 2007 and 2012 (with a total revenue of 66.8 billion and 38 billion dollars, respectively, for the year 2012) (Datamonitor, 2008a and 2008b). It can be established that the present products offered by agricultural biotechnology, as opposed to bio-products resulting from the various forms of organic production, do not provide added values to consumers regarding either comfort or a healthy diet. Thus, in this respect the maintenance, and in fact the support, of organic production, seems to be economically more rational in terms of agricultural policies than the support of biotechnology.

# 5. Conclusion

From the time of the appearance of biotechnology in agriculture in 1996 until the present day, the new technology has spread rapidly in terms of the area on which these products are produced, the number of producers, and the size of the established market value. However, more than a decade has passed and has not proven to be enough for agricultural biotechnology to become globally accepted and widespread. Only a handful of countries are responsible for the majority of the area on which GM crops are produced, and they also provide the majority of farmers and market values. Although agricultural biotechnology has developed and offers new and innovative products, opposition towards the technology and its products has still not abated. Regarding its necessity and allure, the negative feelings still remain and have not been lessened by the experiences gained through production and consumption. From an economic point of view, all this is understandable since agricultural biotechnology is accompanied by unavoidable external effects. These external effects also have negative results on the other agricultural activities that are not based on agricultural biotechnology and thus negatively influence the economic players, especially the forms of agriculture that are based on the traditional genetic diversity of grown crops and the various forms of ecological farming as well as conventional farming. The products of agricultural biotechnology are thus, despite their novel and innovative aspect, lead the economy to failure and can be considered different that conventional (substitute) products.

Agricultural biotechnology products continue to potentially transform the food supply chain, since they unequivocally increased and increase concentration within the sector, primarily on the agricultural input market. This leads another market failure into the economy, since they strengthen the monopolistic type market structure, the existence of which is not necessary in this sector, due to its nature (meaning a natural monopoly does not exist). On the basis of results obtained thus far, concentration in the sector did not only result in an economic and political strength on behalf of the input side of supply, but also led to the decrease in the ambitiousness of R+D (meaning it also negatively affects innovation, as well). All the market failures support the argument as economic reasons that stringent regulations are definitely needed in the case of agricultural biotechnology (see Jackson–Villinski, 2002).

Summarizing the experiences, strategies, and approaches of the players in the food supply chain, the beneficial effects of agricultural biotechnology that would increase competitiveness fail to manifest themselves. On the level of farmers, the application of agricultural biotechnology results in mixed experiences. Advantageous effects can indisputably also be found in given areas and times on the level of certain farming communities that have switched from conventional agriculture to agricultural practices based on GM plants. These advantages can be found mostly in certain dimensions of agronomical practice, such as the use of simpler plant protection products and the more flexible application of labour. At the same time however, an increase in profitability on the level of the farmer cannot be unequivocally established. This stems partly from the fact that according to experiences gained in North America indicate that the decrease in the use of plant protection materials begins to abate after the first three years and commences to rise to a level higher than previously, thus decreasing the profits of farming. The improvements in environmental conditions that are promised by the supporters of agricultural biotechnology are

also nullified. The decrease in competitiveness of farmers can be attributed to partly the effects of the international market, since American farmers have experienced a substantial drop in market share due to the opposition met with in certain main export markets. This conclusion is also substantiated by analyses conducted on the level of the national economy: if export markets do not accept GM products, this can lead to decreases in well being in food exporting countries. Thus leads to a decrease in market share and to a rise in production costs, due to the costs of segregation and identity preservation.

The opposition and refusal of consumers regarding GM foods even led to boycotts in certain cases and cannot be deemed either a temporary or spatially isolated incident. On the contrary, it seems that the opposing behaviour of the majority of European consumers is permanent and has affected the whole supply chain. The commercial food retailers who are afraid for their market positions, own brands, images, and finally their competitiveness and who are presently the strongest economic players in the food supply chain, have all taken provocative steps by either ensuring their whole supply chain is free from GM products or by introducing labelling systems, the costs of which are paid from by the other players in the supply chain. It is thus difficult to imagine from an economic point of view that countries exporting their products to the European market or to certain Asian markets could increase their competitive advantage by averting to the production of GM crops until the consumers on the export markets are opposed to GM foods and require those to be labelled. The costs of segregation and identity labelling are themselves quite high, since they practically require the development of parallel supply chains. Brands and images, as well as the related food safety, health, and other quality expectations that are posed by consumers, seem to be becoming an ever stronger determining factor on the food market. The negative associations of consumers are especially strong in the case of first generation GM crops and the connected food products and the GM products are accordingly disvalued. On the other hand, bio-products resulting from ecological farming practices are enjoying beneficial market images and increases in market demand. For agricultural policies that take into account the characteristics of consumer demand, it seems to be economically more rational to support and help spread ecological production as well as to make it more size economic than favouring agricultural biotechnology.

The majority of analyses conducted on a macroeconomic level attempt to arrive at conclusions concerning the various economic relations of GM products from the point of view of expected changes to the common good and well being by utilizing abstract and theoretical models. When including the heterogeneity of consumers and farmers, and by assuming market failure to be endogenous, these models tend to show that the production of GM crops in those countries where consumers demand non-GM products leads to a decrease in well being. A further message the models have is that there is no optimal economic solution to the question of labelling (indicating GM content), since the interests of various groups vary on a large scale. Labelling is therefore decidedly a normative, political issue which is decided in the strife of interests of the various groups on the basis of their political influence. Certain analyses conducted on a macro level also show that a relationship with the reordering of international competitiveness exists: for example, between the decrease of the international competitiveness of the United States on the soybean market and the spreading of GM soybean in North America, the benefits of which were at least in part reaped by Brazil, as its supply of GM-free soybean could be sold on a larger market in those importing countries that demand non-GM foods. Other studies also call attention to the fact that the production of certain GM crops could have outward radiating negative effects, such as the detrimental effect of GM oilseed rape on conventional organic varieties as well as on honey producers. Thus, when economically evaluating agricultural biotechnology, agricultural policies must calculate with quite extensive economic effects, which influence the normal business conduct and well being of numerous players of the economic markets.

It follows unequivocally from the above that the growing of both GM and non-GM plants (coexistence) and the possibility of implementing the various types of agricultural practices is a very important question. On the basis of the analyses described above, it can be concluded that coexistence does need to be refined in agronomical practice and it also results in costs to the individual players that are far from negligible. The characteristics of the ownership of land in a given region substantially influence the economic viability of coexistence. Land divided into small plots and the prominence of numerous small family farms as opposed to large land owners all increase the price to be paid for coexistence and decrease its economic viability within a given region. This is especially true if ecological farming exists or can be considered to be widespread in the given region or if labelling and protecting the geographical source constitutes an important added market value. The appearance of agricultural biotechnology in a region where any one of the previous characteristics is relevant will substantially transform the structure of the agronomy and will in all likelihood lead to the disappearance of certain agricultural strategies. It is doubtful whether this would lead to increased competitiveness; it seems to be more likely that the majority of farmers would be forced out of the market and would have to give up their farming practices. If however the market for regional items and bio-products increases in size in a faster degree due to the rising consumer demand, or if it promises better revenues than the production of GM foods, then on the whole the given country will experience a decrease in the competitiveness of the agrarian sector. It must also be noted that agricultural biotechnology also raises societal issues of justice, since its benefits and disadvantaged will not be sustained by the same societal groups. And which groups of society agrarian policies should favour and in what way they should do so cannot be simply the question of an economic optimization, as it inevitably becomes an issue of societal policy and justice.

On the basis of our overview of the literature, we have drawn the following conclusions and make the following recommendations for agrarian polity in Hungary:

- On the basis of the experiences gained thus far, there is no evidence to indicate that the production of first generation GM crops improves the productivity or decreases the costs of farmers to result in increased competitiveness.

- The majority of consumers in both Europe and in Hungary is opposed to GM foods, does not whish to consume GM products, and expects GM products to be unequivocally labelled in order to guarantee customers the right to freely make their choice. The characteristics of the market demand do not make it economically feasible to avert to the production of GM crops or to support their growing.

- The tendencies exhibited by the food market indicate that comfortable, safe, and healthy foods are going to continue increasing market share. In the eyes of consumers, the GM products presently available do not meet these criteria and consumers do not feel that these benefits would be attained. In fact, they generally increase an uncomfortable feeling in consumers, decrease the trust that consumers have in foods and in the related institutional system, which can easily have a backward effect on the competitiveness of the agricultural sector in the form of food scandals.

- Consumers are not in need of more information concerning GM foods, but their trust should be increased regarding the safety of the food supply chain, the regulating authorities, and the creditability and legitimacy of the other players on the market.

- The freedom of choice of farmers can be upheld through the continued application of coexistence regulations. At the same time however, thorough and detailed regional evaluations are necessary to be able to assess economic feasibility next to technological sustainability. In the case of certain circumstances or characteristics, the production of GM crops in certain regions can lead to a decrease in the competitiveness of the agricultural sector by taking away the possibility of ecological farming as well as the competitive strategy based on geographical labelling concerning source and protection.

- The application of biotechnology in agriculture transforms the agricultural ecosystem and can also manifest effects on numerous levels of biodiversity; these affects will not limit themselves to areas under agricultural cultivation, but will irreversibly influence even natural protection areas in a manner that cannot be anticipated beforehand. Agricultural ecosystems are important parts of European and Hungarian nature protection and serve as institutes for the protection of biological diversity. It is well known that the EU gained a significant environmental contribution with the accession of Hungary. A price can basically not be put on the economic value of this asset, although it also appears in several sectors besides agriculture (for example, tourism). The effects of agricultural biotechnology thus include these sectors and their values and result in consequences that cannot be scientifically foreseen – precaution is therefore very much substantiated.

- The application of biotechnology in agriculture can have an effect on agriculture that totally transforms its social characteristics and traditions. Its effects on ownership structures, market relationships, the use of certain regions and microregions, and biodiversity will all have effects on society by benefits and costs being distributed in different degrees between the various concerned groups. Agricultural policies therefore have to face issues of societal justice. This demands that all those involved in domestic agriculture participate in a democratic forum that includes a wide stratum of society and that concerns the future of sustainable agricultural practices.

If agricultural polity wish to judge the economic feasibility of agricultural biotechnology in Hungary, it must face numerous difficult decisions and cannot avoid normative (political and ethical) issues, as agricultural biotechnology, conventional agriculture, organic farming, and traditional agriculture hold varying futures that cannot in all cases be reconciled with each other (see Levidow–Boschert, 2008; Marsden, 2008). A large advantage of the polemic concerning agricultural biotechnology from a societal policy point of view is if a debate based on a wide participation of society would develop concerning the future of Hungarian agriculture and the agricultural sector.

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