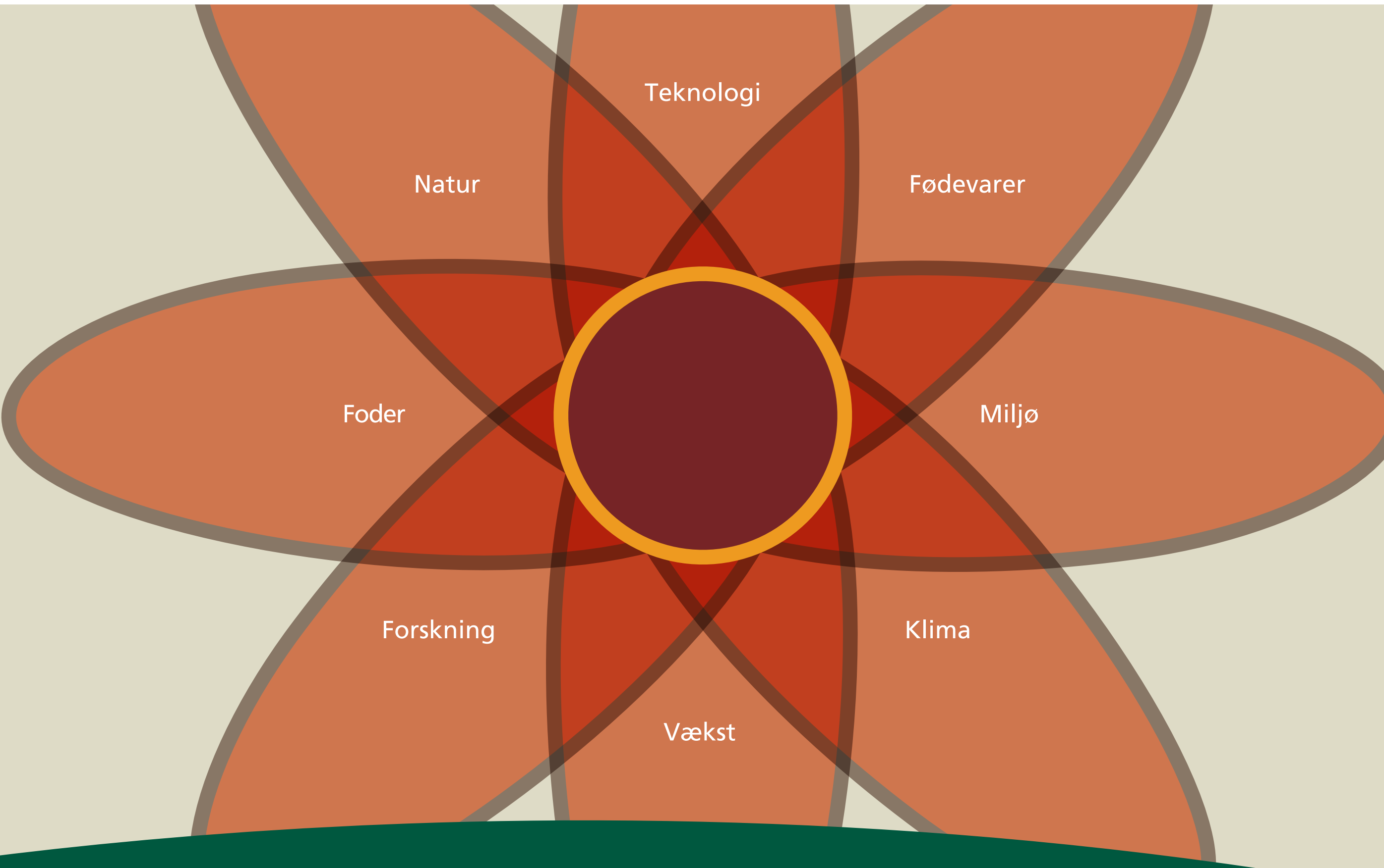
Ministry of Food, Agriculture and Fisheries



GMOs
- what´s in it for us?

Summary of a fact report on the use of genetically modified crops in agriculture and food production, prepared by the Ministry of Food, Agriculture and Fisheries

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Preface

Let's get rid of the myths on GMOs

By Minister of Food, Agriculture and Fisheries Eva Kjer Hansen

The debate on genetically modified organisms (GMOs) is full of myths. Twenty percent of all Europeans believe wrongly that their own genes can be modified if they eat GM food. And one in three believes that genes are found only in GM tomatoes and not in traditional tomatoes.

Sound political choice is based on a sound political debate. So far, the debate has focused mainly on the possible risks. Unfortunately, the opportunities and benefits that modern biotechnology can provide us with have not been focused on in the debate. Therefor we found the compelling need to produce this fact report concerning GMOs.

Mankind has through plant breeding developed new plant varieties for thousands of years, with greater yields and better-tasting crops as a result. In other words, there is nothing new in modifying plants' genetic material. What is new is that gene technology allows us to do this far more precisely and faster than before.

Modern biotechnology is seen upon with scepticism by the population and this fact should be taken seriously. However rejecting genetically modified crops in advance means there is a risk that we will fail to see a number of great benefits deriving from the development of plants that would otherwise be good for the environment, developing countries, health and the climate.

The use of GMOs today

Gene technology is widely used today in medicine production. On a daily basis diabetes patients use insulin produced with the aid of gene technology. Similarly, we can benefit from the use of gene technology when producing food. Consequently I see a need for an open debate on modern biotechnology and genetically modified crops - a debate that is based on facts, not prejudices, a debate where the risks and benefits of GMOs are put into perspective and in the correct proportions.

GMOs globally

Throughout the world, researchers are in the process of developing useful genetically modified crops that can be cultivated in our part of the world and in developing countries.

At the present time, researchers are conducting cultivation trials at several locations in Europe with a GM potato that is resistant to potato blight. This can have great influence on the use of pesticides, as potatoes must be sprayed against potato blight an average of seven times during a growing season. By developing new types of potatoes that require fewer pesticides, gene technology can contribute to a more considerate form of farming, which can lead to greater biodiversity.

One example of a newly developed GMO that can be used in developing countries is drought-tolerant maize which will probably be ready for cultivation in four to five years. In connection with future climate changes it is worth mentioning GM rapeseed that absorbs nitrogen from the soil more efficiently. One third of farming's total emissions of greenhouse gases derive from nitrogen. Farming is in fact responsible for almost one third of all greenhouse gas emissions. We can help resolve this problem through the use of genetically modified crops.

These examples demonstrate how genetically modified crops can help us deal with some of the challenges we re faced with

GMOs in Denmark

Authorities should authorise genetically modified organisms only when they have been assessed as safe. The criterion for authorisation should be based on risks and nothing else. Nevertheless, socio-economic benefits and risks are also relevant when assessing the genetically modified organisms. A description of the socio-economic risks and benefits can help clarify why using crop is interesting.

Through foresight, Denmark has been prepared for cultivating GMOs for some time. In 2004 we adopted the co-existence legislation, which ensures that both traditional and organic crops can be cultivated without the risk of contamination by GMOs. At this moment there are no genetically modified crops that are suitable for cultivation in Denmark, but this could however change very soon.

We should prepare ourselves for that day through a sensible debate through which we can rebut as many myths as possible.

It is my objective that this fact report will be the starting point of a debate through which we will say goodbye to rumours and tales and use our time on facts.

The aim of this fact report

The Ministry of Food, Agriculture and Fisheries'aim with this fact report concerning GMOs is to contribute to a sober and fact based debate on the use of GMOs in farming and the food industry, in both Denmark and the rest of the world. This way the stated sectors, consumers and politicians can be helped making decisions on an enlightened basis.

This fact report deals primarily with genetically modified plants because their use in farming and the food industry is currently focused upon. Genetically modified microorganisms are already an integrated part of the production of ingredients for the food, feed and medicine industries, while genetically modified livestock are not yet relevant and therefore of limited interest to consumers. Thus the focal point is the debate on the socio-economic benefits and risks of genetically modified crops and whether they should be used for animal feed and food.

Consumers and politicians have called for an assessment of the use of GMOs so they will have a tool helping them decide whether we want to use GMOs or not. Therefore this fact report contains not only factual information about GMOs and products made from them. It aslso contains considerations concerning their socio-economic benefits and risks, reagrding their use that are not only relevant today but also tomorrow.

The structure of the fact report

The fact report consists of three parts:

Part 1	The Ministry of Food, Agriculture and Fisheries' annotated summary
Part 2	Facts, status and regulations, written by Ministry of Food, Agriculture and Fisheries experts
Part 3	Research results and assessments written by researchers at: the Institute of Food and Resource Economics of the University of Copenhagen; the Faculty of Agricultural Sciences at Aarhus University; the National Environmental Research Institute, also at Aarhus University; and the National Food Institute at the Technical University of Denmark. These four institutes are responsible for naming the researchers that wrote the text for this fact report, and they are also responsible for its contents. The mandate under which the research institutes worked is given in Annex 1 of the fact report, and the contact information for the individual authors is given in Annex 2.

This document contains Part 1 of the fact report, the annotated summary, in English.

Annotated summary of the fact report

By the Ministry of Food, Agriculture and Fisheries

This paragraph is the Ministry of Food, Agriculture and Fisheries' annotated summary of the fact report concerning GMOs. It is divided into four parts:

I: Facts concerning GMOs, their extent and regulation
II: Research results – benefits and disadvantages of GM crops
III: The potential of increased GM cultivation
IV: Opinion formation and socio-economic benefits and risks

I: Facts on GMOs - their extent and regulation

I.1 A GMO is an organism where new genes have been inserted

GMO is an abbreviation of "genetically modified organism". It is defined as an organism in which the genetic material has been changed in a way that does not occur naturally through reproduction and/or natural recombination.

The techniques that are used to produce GMOs are called genetic modifications, genetic technologies or gene splicing. These three terms describe the same thing – techniques that make it possible to change the genetic material in e.g. plants, animals or microorganisms in a way that does not occur in nature. The changes can occur by inserting DNA into an organism, altering the expression of already existing genes or by fusing living cells so new combinations of genetic material arise.

GMOs are living organisms, such as potatoes that can germinate, or maize seeds.

In this fact report, crops that are genetically modified are termed 'GM', for example GM maize. Products that are produced from GMOs are termed 'GM', for instance GM animal feed. A genetically modified product can comprise, contain or be produced using GMOs.

Animals that have eaten genetically modified feed are not GMOs because the animals' genes have not been altered.

I.2. Modifying genes is not new

The fact that mankind changes the genetic composition of plants and animals is not a new procedure. This has actually been done for thousands of years through breeding of better crops and animals in traditional ways. Farmers have always sown grain from the field that gave the best yield the year before, and they have always let the biggest and meatiest bull into the field with the best cows.

Plant breeding, irradiation or chemicals have also been used to produce changes in the genetic material; the plants with the desired properties were then selected. The disadvantage with this technique is that the number of mutations and the genes in which they occur are unpredictable.

Today we also have gene technology at our disposal. Using this technique we can breed in a more targeted way than before. For example, we can mix together properties from different species. With genetic modification, the task of improving species through breeding has been given a new tool.

I.3 GM crops are cultivated on 8% of the world's agricultural soil

Commercial cultivation of genetically modified crops (GM crops) started in the middle of the 1990s. In 1996, 1.7 million hectares (ha) of genetically modified crops were grown around the world. Since then, the total area of GM crops in the world has increased every year and had risen to 125 million ha in 2008. This equals 8% of the world's agricultural soil, and represents an increase of almost 10% compared with 2007.

GM crops were grown in 25 countries in 2008. Half of the total area used for GM crops was in the USA (63.5 million ha), followed by Argentina (21 million ha), Brazil (15.8 million ha) and India and Canada (both 7.6 million ha).

At the moment, only one GM crop is grown in the EU – a type of maize called MON810, which is resistant to attacks by the European corn borer.

In 2008, the total area in the EU with MON810 maize was 108,000 ha, which is less than 1% of the global area with GM crops. MON810 maize was grown in Spain, the Czech Republic, Romania, Portugal, Germany, Poland and Slovakia in 2008. It was grown on approximately 80,000 ha in Spain alone.

I.4 No GM crops are grown in Denmark yet

As yet, no GM crops are grown in Denmark, partly because no GM crops suitable for cultivation by Danish farmers have been authorised. The GM maize that has been authorised for cultivation in the EU is not relevant for Danish farmers because the pest to which it is resistant is not a problem here.

I.5 Widespread use of GM animal feed for livestock in Denmark

GM animal feed for livestock is widely used in Denmark. In particular, genetically modified plant products for feed are an important source of proteins for pigs, poultry and cattle, and are found as meal and cake from oil-rich seeds and kernels. Especially soya meal and soya bean cake, which account for about two-thirds of the world's overall consumption of protein meal, are of great importance.

Danish imports of soya meal and soya bean cake in recent years have been approximately 1.6-1.8 million tons a year, with most of it coming from Brazil and Argentina. A realistic estimate is that approximately 80% of this is produced from GM soya. The annual consumption of mixed compound feed in Denmark is estimated at 8-10 million tons.

I.6 Only a few GM food products in the world

Food products made from GMOs are rare at the moment, although the trend leads towards more food products with genetically modified ingredients. A number of genetically modified variants of maize, soya, rapeseed, cotton and sugar beets have been authorised for use in food in the EU, but the number of food products made from GMOs remains limited. However, some products get on to Danish supermarket shelves from time to time. These products are labelled so consumers can see that they contain or are made from GMOs.

Food products made from GMOs are found more frequently in other EU countries than in Denmark. A survey in 2008 found 69 different GMO-based products in food shops in various EU countries such as Greece, Slovenia, Sweden, Czech Republic, Estonia, Germany, the Netherlands, Poland, Spain and Britain. The GM food products that were found were comprised popcorn, fish fingers, snacks, mayonnaise and chocolate bars. The existence of genetically modified material in all of the products was completely legitimate.

I.7 Rules ensure that GMOs are safe

The EU rules that regulate GMOs are comprehensive and complex. For instance, genetically modified products must go through a long authorisation process, which includes assessing their risks to health, agricultural production and the environment, before they may be used. The extent of the risk assessment depends on whether the products are to be authorised for import orfor cultivation in the EU. The most comprehensive risk assessment is for GMOs that are to be authorised for cultivation in the EU or when it is a matter of viable seeds because of their possible environmental impact.

The EU regulations also require food products or animal feeds that contain or are produced from GMOs to be labelled.

Danish regulations for coexistence between GM, conventional and organic crops

All of the common EU rules applying to GMOs also apply in Denmark. In some areas, the EU rules only set a framework, and there are therefore national rules. For instance, this applies to coexistence between genetically modified, conventional and organic crops. The Danish regulations for coexistence were set out in 2004 and they have been a model for the legislation in a number of other countries.

Ongoing debate on GMO regulations

The GMO regulations are continually discussed and developed. The discussions derive from a number of concrete problems such as:

- Lengthy authorisation procedures makes it less attractive to start developing new GM crops
- Zero tolerance for non authorised but risk assessed GMOs impedes trade with third countries
- Lack of threshold for GMOs in seed causes problems for cross-border trade
- Discussions of the use of GM crops with antibiotic resistance marker genes
- Discussions on wether to take the socio-economic risks and benefits into account in the authorisation process

II. Research results – benefits and disadvantages of GM crops

The following pages examine the overall conclusions of the fact report with regard to the benefits and disadvantages of growing and using GMOs, with the focus primarily on Denmark and secondarily on the EU and third countries.

The conclusions are divided into:

- Research results, based on chapters 4 and 7
- Benefits and disadvantages for the environment, based on chapter 5
- Life-cycle analyses – a holistic assessment, based on chapter 5
- GMOs and the climate, based on chapters 5, 6 and 7
- Economic benefits and disadvantages, based on chapter 7
- Trade and barriers, based on chapter 7

For most of these areas, our knowledge is based on relatively little experience and few studies, and most studies are highly context depended. For the most part the conclusions therefore indicate that further research and compilations of experience are necessary to give a more complete picture of the benefits and disadvantages of GMOs. But fundamentally the studies show that GM techniques have a great potential, which, under the right conditions, can be an important tool for future breeding improvements and for food technology.

II.1 Research into genetically modified plants

Research into GM plants is partly about developing plants with new, beneficial properties for use in farming, medicine and industry, and partly about studying how the new organisms can be expected to affect health, agriculture, nature and the environment. In addition, research covers how GMOs impact society and the economy. As part of the authorisation procedure, the companies that develop GM plants must conduct and submit their own studies of the GMOs' health-related properties in a way that gives the authorities sufficient basis for approving or rejecting the new GMOs. These studies can be laboratory tests, trials with plants in greenhouses or trials in experimental fields. In addition to these statutory studies, research is also carried out under programmes that are funded nationally and internationally.

Research into GMOs is carried out in Denmark, the EU and third countries. The results are summarised in the following paragraphs.

Trials that show equal yields, lower pesticide use and greater agronomic sustainability

Most cultivation trials in Denmark have been with GM crops where it is possible to use herbicides with a lower impact on the environment than in conventional weed control. At the same time, growing the GM crop means that the farmer can spray against weeds in the field later in the growing season, something that otherwise cannot occur because the crop could be damaged. The benefit is that the farmer can use another spraying technique and thereby in many cases spray less.

A number of trials with glyphosate-resistant fodder beets showed a lower herbicide use and thereby a lower negative impact on the environment than with conventional beets and traditional use of herbicide. The trials also showed that, for most weeds, satisfactory weed control was achieved by postponing the spraying, which can benefit cultivation and can improve the biodiversity in the field. The yield of the GM beets was on a level with conventional beet varieties.

Overall, the trials showed that the same yield can be achieved with lower pesticide use with GM crops.

Demonstration trials were carried out in 2007-2008 with glyphosate-resistant GM maize (NK603). As with the fodder beet trials, the maize trials showed that it is possible to get satisfactory weed control with lower use of herbicides and that spraying can take place at a later time.

The Danish results are confirmed by experience abroad. Herbicide-tolerant soya beans are the most widespread GM crop in the USA. Soya beans compete poorly with weeds, and effective weed–killing was difficult to perform before herbicide-tolerant soya beans were introduced. These soya beans can now be grown on areas previously unsuitable for growing soya beans, and the time for and duration of weed-killing are no longer as vital. Production has thus become considerably morepredictable. During the 12 years that herbicide-tolerant soya beans have been grown in the USA, the variation in yield has decreased and production has become more stable on areas not previously considered suitable for growing soya. In addition, cultivating soya beans has generally become easier for the farmer.

However, the introduction of GM soya and maize has so far not resulted in a greater rise in yield over time than the historic increase in yield achieved through traditional plant breeding.

Dispersal of GMO's to other crops can be avoided

Much of the research has focused on the dispersal problems associated with cultivation of GM crops. Dispersal can in certain cases be a problem either for the ambient environment or for sales, because GM crops and conventional crops must not be mixed. Dispersal paths can either be characterised by the crops' biology or related to human handling of the crops.

Examples of dispersal paths are:

- Cross-pollination
- Plant wastage
- Sowing
- Using machinery, transport and handling for both GM and non-GM crops
- Agricultural structure
- Production conditions
- Areas outside rotation

Various scientific models have been developed to help reduce pollination between GM crops and neighbouring conventional and organic crops. These models can be used in connection with assessments of the possibilities of practical coexistence between GM crops and other crops. The tools that form the basis for safe coexistence are thus available.

Changes in farmers' growing practices are vital to the result

Danish researchers have studied how Danish farmers possibly would use herbicide-tolerant GM crops. This study is hypothetical, as Danish farmers do not yet cultivate GM crops. It is therefore uncertain whether the study actually reflects the use of herbicide-tolerant crops in practice.

The study indicates that the individual farmer's opinions and cultivation-related assessments can be a barrier to realising possible environmental improvements from the use of herbicide-tolerant crops. A condition for achieving positive effects in the form of increased biodiversity in and around the field is the farmer's willingness to change his crop-spraying practices and avoid supplementing with other herbicides. Danish farmers' tradition for consulting the agricultural advisory service will probably help break this barrier down.

II.2 Benefits and disadvantages for the environment

The basis for the report's conclusions is a division of the GM crops into herbicide-tolerant crops and insect-resistant crops, which are the predominant GM crops on the market today.

Herbicide-tolerant crops:

Less-toxic crop sprays, less soil preparation, less soil erosion

According to most of the research into the use of herbicide-tolerant crops, growing herbicide-tolerant beets can result in a benefit for the environment compared with conventional cultivation. However, this benefit requires crop-spraying later in the season or with a reduced dose. Together with environmentally friendly cultivation forms, herbicide tolerance makes it possible to achieve environmental benefits. These benefits thus depend on agriculture making use of the opportunities presented by genetic modification. Information and presumably legislation is required if the changed practices are to be widespread with the introduction of herbicide-tolerant GM crops.

Experience also indicates a number of benefits from growing herbicide-tolerant crops, such as:

- Reduced soil preparation, which is also beneficial for biodiversity. Reduced soil preparation also means a reduction in greenhouse gas emissions, both as a result of lower fuel consumption during cultivation and through higher carbon binding in the soil.
- Reduced soil preparation also results in less soil erosion and lower leaching of nutrients (including leaching of nitrogen to the aquatic environment). Less erosion and lower leaching are especially important for the yield and agronomic sustainability in developing countries, where the soil is often low in nutrients. Changing to herbicide-tolerant crops results in a switch to less toxic herbicides.
- Delayed crop spraying can lead to an increased number of arthropods, and thus greater biodiversity, in the field.

Risk of developing resistant types of weed through lack of rotation

Foreign experience, on the other hand, also indicates disadvantages with herbicide-tolerant crops. The disadvantages arise in particular if the farmers grow crops that are only sprayed with the same herbicide for many years in a row in the same field. This can lead to problems with weeds developing resistance and thus greater pesticide use than under optimal conditions. A rather comprehensive British study from 1998 shows that the important factors for plant and animal life are herbicide type and spraying practice, and not whether or not the crop is genetically modified. The study also showed that there is a risk that cultivation of GM crops can contribute to a reduction in biodiversity in the cultivated area if cultivation practices are not changed.

A special type of problem is associated with the risk of developing weed types that are resistant to various herbicides. The problem is greatest in those areas where large quantities of herbicide-tolerant crops are grown. Up to 1994, for example, glyphosate was not used to the same extent as after 1994, when glyphosate-resistant crops became more dominant. Until then there were no reports of glyphosate-resistant weed types, which was probably due to a combination of crop-spraying practices and soil preparation. Using only glyphosate as weed killer, combined with the use of reduced doses of glyphosate and reduced soil preparation, increases the probability that plants that can survive low doses of glyphosate will be favoured and this creates problems in the cultivation system. This tendency has been seen for example in the USA among types of white goosefoot and black bindweed.

Insect-resistant crops

Reduced use of pesticides gives greater biodiversity

The possibility of reducing crop spraying with insecticides through cultivation of GM plants is first and foremost associated with crops that are resistant to certain types of damaging insects.

In practice, the insect-resistant plants are modified to produce substances that are naturally formed by the *Bacillus thuringiensis* (*Bt*) bacteria. These substances kill some of the insects that damage the plant. A genetic sequence from the *Bacillus thuringiensis* bacteria is inserted into the insect-resistant *Bt* crops. When the *Bt* toxin is a part of the plant, it predominantly targets those insects that damage the plant. This specificity means that insect control using GM insect resistance has the potential to be more environmentally friendly than traditional insect control techniques.

Preliminary studies show the following benefits:

- Using insect-resistant varieties of crops that require most use of pesticides can more than halve the consumption of insecticides, which are often damaging to the health. One example is the use of *Bt* cotton.
- Reduced insecticide use can increase the proportion of valuable insects in the crops, which has been seen in China and elsewhere.
- GM plants based on *Bt* genes appear to have no negative impact on honey bees, while the impact of other types of GM plants on bees has not been studied thoroughly.

Laboratory trials shows toxic effects and resistance

Bt plants contain toxins and this has brought the negative consequences of *Bt* plants into focus. The focal point has been to study whether the increased quantities of toxins from the plant material can affect nature and the environment. This could happen if plant material containing *Bt* toxins affects harmless or beneficial insects, or if *Bt* toxins, released as roots and leaves decompose, affect arthropods in the soil or aquatic environment.

Among other things, laboratory trials have shown the following:

- *Bt* toxins can impact on sensitive species through direct toxicity. But it has not been possible to show equivalent effects on species or the environment in natural growing conditions. It is a theoretical possibility that insect-resistant crops can cause changes in the fauna as the plant-eating insects are part of the arable food chain. The insect-resistant crops can thus have derivative effects on other parts of the fauna, both because the food basis becomes smaller and because its quality changes. The conclusion is that the existing information does not enable us to predict the changes to the fauna that insect-resistant crops will cause, and there is a need for further studies.
- To date, two examples have been found of insect species (*Helicoverpa zea* and *Plutella xylostella*) that have developed resistance to *Bt* toxins (*Bt* maize and *Bt* cotton). This has only been shown in laboratory tests. Other insects have the potential to develop resistance. Cultivation methods where the crops have different *Bt* toxins and where the landscape structure gives the insects refuges both inside and outside the field and can help counteract the development of resistance.

The problem with the conclusions concerning *Bt* crops is that the majority of the studies were conducted in laboratories or on a small scale. It is unclear how relevant the studies are for large-scale GM crop cultivation. Experience from several laboratory studies has no importance in field studies for various reasons. For example, a field study of the effects of maize pollen found on monarch butterflies in the laboratory showed they were smaller than with conventional insect control using insecticides.

II.3 Life-cycle analyses – a holistic assessment

The environmental assessments of GMOs that have been carried out to date have often focused on the effects that occur on agricultural soil. When the environmental impacts of various production methods are to be compared, they are normally expressed in terms of area. These assessments are limited, because only certain parts of the production chain are included.

With life-cycle analysis (LCA), the environmental impact is expressed in terms of the unit produced, for example per kilogram of sugar produced, and environmental impacts from all of the important processes in the life cycle are included. This means that, for example, the environmental impact of the production of the amount of artificial fertiliser used to produce 1 kg of sugar is included in the assessment. LCA means that, in principle, all environmental effects in the production chain, "from cradle to grave", are included. For food production, the life-cycle perspective means that it is not just the environmental impacts deriving from production on the farm that are included – environmental impacts that are connected with the production of the end product and the use of ancillary materials such as pesticides, diesel and fertilisers are also included.

For agricultural crops, different production methods often involve varying consumption of ancillaries, a different yield per unit of area and different emissions from production. This will normally also be the case when comparing GM products with non-GM products. LCA is an appropriate method when comparing these differences, so an expression of the environmental impact per produced unit of an agricultural product can be obtained.

II.4 GMOs and the climate

There is considerable interplay between soil quality, climate and plant production. A more extreme climate with longer periods of drought and more intense precipitation makes greater demands on the quality of the cultivated soil and cultivation techniques.

The world's food production must be increased greatly in the coming years. But to double food production with the same rises in inputs that we have seen to date means we will use three times as much nitrogen and phosphor fertilisers, while the irrigated area will double. This will have unacceptable consequences for the environment and the climate, and new crops, varieties and cultivation methods are therefore necessary to ensure both higher yields and a low impact on the environment. GM is a promising technique for producing plants that are more tolerant towards changed climatic conditions.

Unlike many other countries, Denmark is in a situation where climate changes do not reduce the opportunities for farming. In all probability, the global demand will mean that areas such as Denmark, with good agricultural soil, will have good sales possibilities for agricultural crops.

Generally we will probably see GM crops becoming increasingly common. This applies to both the GM crops that we know today and to new crop types that are adapted to climate changes or that produce special products, for instance vaccines or biodiesel.

Some GM crops open the way for cheaper and more effective weed control and this means it is more attractive for farmers to cultivate the soil with reduced soil preparation. This has several positive environmental effects. Among other things, this gives a reduction in CO_2 emissions – partly as a result of a cut in the use of fuel, because the farmer does not need to use his machinery as often, but mainly because of higher carbon binding in the soil.

Life-cycle analyses that compare GM crops with non-GM crops have been conducted for sugar beet and maize. In both cases, the GM crop has immediate positive effects with a 10-35% reduction in greenhouse gas emissions and a 10-60% reduction in emissions that erode the ozone layer.

II.5 Economic benefits and disadvantages

Until now, the introduction of GM crops has had an economic goal, e.g. higher yields, lower expenditure on pesticides and greater agronomic sustainability. In the following paragraphs, costs and benefits from cultivation of GM crops are examined. The conclusions focus on both the farm and societal level.

As a rule, the conclusions on the economic aspects of cultivating GM crops are very context depended and related to the individual GM crop. The economic aspects depend on the type of crop and the cultivation practices, as well as on the legislation. The law on coexistence between GM, conventional and organic crops in particular can reduce some of the GM products' benefits compared with costs of labelling and separating GM and non GMO products in the whole food chain. To maintain a well-functioning economy, it is important to have a well-functioning market. Different authorisation procedures and threshold values for GM content can thus lead to limits in trade. There is more on this in section II.6 "Trade and barriers".

As GM crops are not yet cultivated in Denmark, and the crops are only grown to a limited extent in the rest of the EU, the knowledge basis is still very limited for drawing firm conclusions. Most of the conclusions are therefore based on model calculations and experience gained from cultivating the crops in third countries. Experience in dividing the market into GM and non–GM crops with regard to imports is however based on facts.

Economy at the farm level depends on the concrete GM crop

The economic potential for the farm from growing GM crops is highly dependent on the crops that are grown and on the properties of these crops. It must also be expected that this potential will vary from farmer to farmer and will depend on whether the possible savings and the value of a higher yield can balance the extra costs for GM seed for sowing and in ensuring the rules on coexistence are observed.

A number of costs are involved in cultivating GM crops in Denmark. For example:

- Increased expenditure on seed for sowing
- Training (GM 'driving licence')
- Approval for cultivating GM crops
- Administrative tasks (e.g. reports to authorities, record-keeping and informing neighbours)
- A fee of DKr 100/ha of GM crops to a compensation fund
- Requirements for good farming principles, including cleaning machinery/vehicles that have been used for GM crops and control of waste GM plants
- Crop-specific distance between GM crops and conventional and organic fields with the same crops

On the other hand there are also potential savings:

- Lower expenditure on pesticides
- Lower costs for labour and transport (fuel)

The Danish model calculations show that cultivating GM beets and GM potatoes will have a positive potential in economic terms for the farm (of between DKr 400 and 800/ha), while the economic potential for the farm from growing GM maize is slightly negative, as the coexistence costs and the increased cost of seed exceed the potential savings.

GM crops and societal benefits

As with the economic calculations for the farms, growing GM crops involves both higher costs and potential savings for the economy on a larger scale. Mirroring the calculations for the farms' economy the costs will primarily be associated with seed for sowing, and with separating and labelling GM crops, while the economic potential is associated with higher yields, higher agronomic sustainability and lower expenditure on and transport of pesticides. The overall conclusion is that, as a rule, what is good for the economy of the individual farmer is also good in a national economic perspective when the focus is on yield and price levels. The best example is that cheaper GM crops lower the costs in food production. So far it has not been possible to assess the environmental benefits and costs in monetary terms; therefore, there is no overall conclusion on the introduction of GMOs in food production in a broader national economic perspective. Here, life-cycle analyses are currently the best method, cf. the previous section.

From a global point of view, the economic experiences from the introduction of GM crops in agriculture are very varied. However, most of these experiences indicate overall net gains for agriculture. The experiences again depend very much on the crops, area, legislation and cultivation practices. The overall conclusion is that the benefits from cultivating GM crops depend on the concrete conditions in each specific case and clear results are probably best determined by tests in production. The experiences gained from around the world are summarised in the following sections.

Diverse experiences with GM maize in Spain

In Europe, economic calculations have been made for growing MON810 GM maize in Spain, which is the only EU country that has any sizeable commercial cultivation of GM maize. The study shows varying economic benefits between the Spanish regions. In the Sarinena area there was an average increase in yield of approximately 10% when using GM maize, which gave an extra €123/ha in 2002. In addition, up to half of total costs of pesticides were saved. But the result depended on how hard the corn borer hit the individual farm. In another area of Spain, Barbastro, there was no difference in the contribution margins of conventional maize and GM maize.

The study also indicates a number of additional benefits for the individual farmer from the use of GM maize:

- Less risk of crop damage
- Reduced working time with less spraying and monitoring of crops
- Higher crop quality – lower content of mycotoxins (toxic substances produced by fungi) in GM maize
- Reduced risk of accidents for the farmer when transporting chemical sprays

Herbicide-tolerant soya beans give agronomic sustainability in the USA

Early analyses did not find statistically significant economic benefits from the change from conventional soya beans to herbicide-tolerant soya beans in the USA. Therefore, the wide spread of GM soya beans has been explained through unvalued benefits such as reductions of labour costs and agronomic sustainability. Later studies that have tried to put a price on these benefits have shown considerable net profits for the farmers when switching to GM soya beans.

Increased yield with insect-resistant cotton in China and Argentina

Studies in China showed yield increase by 7–10% when using insect-resistant GM cotton (*Bt* cotton) compared with non-GM cotton. The most important effect of *Bt* cotton is 20–33% lower production costs: for *Bt* cotton producers, spending on pesticides averages €27/ha compared with €148/ha for non-*Bt* cotton. An analysis of *Bt* cotton production in Argentina found that the yield for *Bt* cotton producers was 32-34% higher, while the costs for pesticides were cut by more than 50%. However, these improvements resulted in only a limited increased in net profit because of the high price of seed: the price of GM seed was four times that of ordinary seed.

Uncertainties on the benefits of insect-resistant maize in the USA

The yield from insect-resistant maize (*Bt* maize) in the USA was higher than for conventional maize in 1997, 1998 and 1999. *Bt* maize growers nevertheless saw lower earnings in 1998-99. The reason they cultivated *Bt* maize despite this is ascribed to the uncertainties on the impact of pests. However, newer studies indicate that maize producers have also seen a positive net profit from the change to GM types. This applies to the USA and to other countries.

Increased profitability from GM crops in South Africa

Among developing countries, South Africa in particular has adopted GM technologies and their cultivation continues to grow sharply. Maize is the GM crop that is most widespread in South Africa, but GM cotton and GM soya beans are also grown. From accounting for less than 1% of farmland in 2001, GM maize reached 62% of farmland in 2007. The great majority of GM maize is resistant to insect attacks, but herbicide-resistant types are also grown.

A study in 2008 showed an average increase in profitability in 2001-2 from arid soil of US$35, and US$117 for artificially irrigated soil, after the extra cost of GM seed was taken into account. The yield was approximately 11% higher for GM maize and the pesticide costs were considerably lower.

Another study from 2005 among small and resource-weak farmers also showed a yield increase of approximately 11% and lower pesticide costs.

II.6 Trade and barriers

Trade is an almost independent and complex aspect when the economic benefits and disadvantages of GMOs are to be assessed. In a number of countries the value of the GM crops lies in the opportunity for exporting them, while other countries are strongly dependent on being able to import the often cheaper GM crops.

The still-increasing use of GM technologies in many sectors results in growing trade in GM products. For many of the areas where GM products are used, this development is relatively problem-free. But various considerations clash in the food area in particular. This applies especially in the cases where national and regional authorisation processes for GMOs form large barriers to trade, just as different requirements to labelling GM products have resulted in trade-related conflicts.

EU rules give trade problems

In the EU in particular there have been trade problems because exporting countries have started to use new types of GM crops that have not been authorised in the EU. There is no minimum threshold in the EU for the proportion of EU-unauthorised GMOs in a load and the imported load must therefore be completely free from EU-unauthorised GMOs. This means that, to ensure their exports, exporting countries must separate EU-authorised and EU-unauthorised GMOs in the production chain from the time the seeds are sown until the products land in the EU. Such separation is difficult and expensive; and over time it becomes more and more impossible, as a greater proportion of agricultural areas in the exporting countries are grown with new GMOs. Most of the exporting countries have no requirements for coexistence between GM crops and conventional crops and EU-authorised crops will therefore be mixed with EU-unauthorised crops. As the EU is the only important import area that has stringent authorisation requirements, exporters will find the EU market less and less attractive and instead they will direct their exports to less-demanding markets.

EU's livestock production will come under pressure if imports of GM soya stop

The EU Commission has analysed three scenarios for soya bean imports: a minimum impact scenario, where only imports from the USA are stopped; a medium impact scenario, where imports from both the USA and Argentina are stopped; and a worst case scenario, where imports from the USA, Argentina and Brazil are stopped. The worst case scenario is not improbable if the EU maintains its restrictive policies at the same time as new GM types are grown to an increasing extent in all three countries.

The reduced imports from the USA in the minimum impact scenario can mainly be replaced by increased imports from other countries, while there are considerable impacts from the medium impact and worst case scenarios. In the short term, the worst case scenario will lead to a fall in pork production of about a third and to large price rises for pork. This will result in the EU going from a net exporter of pork to a net importer. Poultry production will fall by about 40% and there will also be rising prices and net imports. The EU's exports of beef will disappear completely and imports will be more than quadrupled. These effects will diminish after EU authorisation of the new GM crops, but they will still be felt. However, this is under the condition that new, unauthorised types do not mix with the authorised ones. In practice, however, it is more probable that new types will frequently be released on the market and will be used in exporting countries and that the EU will continuously be a step behind all the time with regard to approving GMOs.

Argentina and Brazil are trying to follow the EU rules by cultivating only plants that are authorised for food and animal feed in the EU.

Livestock production accounts for 40% of the value of the EU's total agricultural production today. A considerable loss of competitiveness resulting from the lack of authorisation of new types as described above will have a pronounced effect on farming incomes, as well as secondary effects on processing and supply companies associated with agriculture. Furthermore, consumers will experience considerable rises in meat prices.

A second very important aspect is the environmental impact of the reduction in livestock production in the EU. In practice this will mean that livestock production will increase in countries where there is far less focus on and regulation of farming's impact on the environment. Globally, the difficulties for the EU's livestock production will thus also have negative environmental impacts.

The EU's citizens and politicians should therefore consider whether Europe wants to pay this higher price for maintaining a separate non-GM production and whether we wish to produce agricultural products in Europe or import them from other countries. Requirements to separated process lines and zero tolerance towards unauthorised GMOs are already impeding a profitable agricultural production and also hitting national economies.

The Ministry of Food, Agriculture and Fisheries supports research into biotechnology that is useful to society

Genetic technologies can help solve some of the present challenges in the environment and climate areas. The Minister for Food, Agriculture and Fisheries has therefore earmarked DKr 65 million for research into biotechnology as part of a new research programme. Among other things, the programme will study what biotechnology in order for the agricultural sector to supply sufficient quantities of good and safe food while simultaneously safeguarding the environment andclimate.

III. The potential of increased GM cultivation

Globally, agriculture faces some fundamental challenges in the 21st century:

- Towards 2050 the world's population is expected to grow considerably. At the same time it is expected that our diet will consist of more animal protein. This is expected to lead to a doubling of the world's meat consumption and a 60% increase in the world consumption of grain between 2000 and 2050.
- The world's total agricultural area amounts to about 5 billion ha. Cultivation of new land will have serious consequences for the environment in the form of lost biodiversity and higher greenhouse gas emissions. There are therefore strong environmental reasons for avoiding this. This implies that yields must rise considerably on existing agricultural land.
- The demand for bioenergy and biofuels is rising. For several reasons the pressure on agricultural areas as a result of this demand can be expected to rise in the coming years.
- There is a rising focus on agriculture's use of resources and its environmental impact, as the quality of cultivating soil is degrading.
- Globally, approximatly 80% of freshwater consumption goes to agriculture's watering activities. In many places ofthe world this results in over-use of water, a fall in groundwater levels and resulting drying-out of rivers, streams and lakes.
- The use of pesticides leaves pesticide residues in food and affects farm workers. They also affect the surrounding environment through leaching to both the soil and the aquatic environment.
- Leaching of nitrogen and phosphorus to the surrounding environment results not only in eutrophication of the surrounding nature but also in the loss of valuable nutrients.
- Agricultural production results in considerable greenhouse gas emissions and is responsible for 14-30% of global emissions, depending on how to account for land use change.

In chapter 6 there are a number of examples of potentials for farming in relation to the challenges agriculture is facing, especially for Danish agriculture. The chapter stresses that the examples described often derive from personal, research-based assessments, as most of the development work aimed at producing new types of GMOs occurs under private conditions and is therefore not available publicly. From a professional point of view, the assessment shows without doubt that sensible use of GM plants can make an important contribution to solving agriculture's existing and coming problems. However, the chapter also stresses that gene technology is a technology that cannot stand alone.

It is a requirement when developing and realising this potential that the necessary funding for research and development is found and that the legislation creates a framework in which the plant breeding companies can achieve reasonable earnings under conditions that avoid monopolisation. Finally, the development and use of GMOs in the EU will depend entirely on the creation of a sensible framework for using GM crops. This means that authorisation procedures without administrative and political time-wasting must be established and they must meet the needs and wishes of consumers.

The development of genetically modified crops is a lengthy process, typically up to 10 years, and for some crops even longer. Genetic modification of plants for solving the foreseeable problems of the future should therefore be part of a long-term strategy with clear objectives, funding and legislation.

The following presents a series of examples of probable future use of GMOs:

Greater tolerance to attacks by viruses, bacteria, nematodes, fungi and insects

Traditional breeding of potatoes takes a very long time. It takes approximately 20 years to transfer resistance genes from wild potatoes to cultivated types. With genetic modification it will probably be to develop potatoes that can tolerate fungi attacks faster. Today, approximately half of the consumption of fungicides used on potatoes is used to control potato blight.

Better tolerance of drought, cold, heat, salt and flooding

Globally, there is a very large research and development effort directed towards producing drought-tolerant crops through genetic modification. The Monsanto company expects to be able to market drought-tolerant maize in 2012. Drought-tolerant cotton and soya beans are also in the pipeline.

Better absorption of nutrients (minerals, phosphate and nitrogen)

Our cereals are particularly effective at transferring nitrogen from leaves and stems to the grain, but other plants such as rapeseed can only mobilise about 50% of the nitrogen reserves from the plant's vegetative parts. Rapeseed with a better nitrogen utilisation can be expected to be commercialised in the near future. This can have considerable importance in connection with reducing nitrogen emissions from agriculture.

Improved nutrient composition in animal feed and reduced nutrient leaching to the ambient environment

A very considerable part of plant production is used as feed. Globally, about 60% of plant production is used as animal feed, and in Denmark the figure is about 80%. Cereals such as barley, wheat and maize are excellent sources of starch, but they have a number of nutritional deficiencies. This can be changed through genetic modification. The individual substances have both nutritional and environmental consequences:

A. Phytase

Phytase is an important enzyme for animals' absorption of phosphorus and thus for cutting phosphorus leaching to the environment. Since the start of the 1990s, research has been conducted into the possibility of producing genetically modified crops that produce greater quantities of phytase in their seeds. This has been successful in crop types such as soya beans, lucerne, rapeseed and maize. In Denmark, this research has concentrated on barley and wheat.

To date, no phytase-producing crops have been launched on the market, because under the existing legislation, the genetically modified plants are not economically competitive with the use of microbe-generated phytase.

B.Amino acids

The proteins that are stored in cereal grain do not have an optimal nutritional composition. Thus there are only small quantities of the so-called essential amino acids, which humans and animals cannot generate but must acquire from their food. In order to compensate for these deficiencies large quantities of imported soya meal are today added to feed.

To solve this problem, Danish researchers have produced genetically modified barley with 10% more essential amino acids, while potatoes with an improved composition of amino acids have been developed in India.

C.Other feed parameters

Further, for feed there are a number of relevant breeding targets that are currently being addressed through research and development of genetically modified crops. For example, as far as forage grass is concerned there is an interest in developing plants that are more easily digested. This can be done by cutting the amount of lignin and by suppressing flowering, as flowering stems are poorly digestible. It is possible to cut methane emissions from cattle considerably by feeding them grass or other coarse fodder crops with a high content of medium chain unsaturated fatty acids. In England, research aimed at developing grass types that will be able to reduce cattle's strain on the climate in this way has been initiated.

Greater ability to compete with weeds

The cultivation of crops that are resistant to herbicides is very extensive. It must be expected that genetic modification will be used to a greater extent for the development of new types of resistance towards herbicides. In addition there is, for example, considerable ongoing research into cultivated plants' ability to compete with weeds through separation of chemical connections or by getting the plants to germinate and take root early.

Healthier food

The main emphasis on the development of genetically modified crops in the commercial sector quite clearly lies in properties that are relevant for growing them in the field, and for feed. But there are also considerable activities that aim at improving the nutritional value of food. These activities can be divided into the following major groups:

1. Vitamins and minerals

The current estimation is that about half of the world's population - primarily women and children in developing countries - lack iron and zinc. In addition, about 500,000 children go blind every year because they lack vitamin A, and many of them subsequently die because of this. The primary cause of these problems is poverty, which means that the population almost exclusively receives its nourishment from staples such as maize, rice, wheat and potatoes, which are low in minerals and vitamins. Solving this problem was given top priority by the Copenhagen Consensus Conference in 2008.

'Golden rice' is an example of the successful development of a crop that produces precursors of vitamin A. Similar precursors give carrots their orange colour. 'Golden rice' is expected to enter normal cultivation by 2012. Rice, wheat and maize with two to three times more iron than normal have also been produced successfully.

2. Oils, starches and proteins

There has been considerable interest in the composition of fats in our oil crops. Currently this includes producing soya beans with an oil composition (low content of linolenic acid) that gives fewer damaging trans fatty acids. Similarly, soya beans with omega 3 fatty acids, which presumably will have a positive impact on human health, will soon be available.

Furthermore, there is ongoing development of crops with starch that decomposes slowly and of crops with a healthier protein composition. These activities are also particularly relevant for human nourishment.

3. Increased or reduced content of secondary metabolites

Some of the contents of crop plants are often regarded as having positive effects on human health, and it has been possible to develop e.g. soya beans with a higher content of antioxidants. In other cases there are clearly documented negative effects of certain plants' naturally occurring contents, e.g. cyanogenic glycosides in the cassava plant, which is a staple food food for several hundred million people in Africa. Very poisonous hydrocyanic acid is released when the starch-rich roots are processed and it is often impossible to remove this unless the cassava flour is washed thoroughly. The formation of these components has been successfully suppressed with the aid of genetic modification.

4. Removal of allergens

Many people are allergic to components in plant-based food. In some cases the allergic reaction is well-defined and here it will be possible to remove the allergy-provoking component through genetic modification.

Good opportunities for more biomass and bioenergy

There seem to be good possibilities that genetic modification can help breed plant variants that will be suitable for producing biogas, biodiesel and bioethanol. An already commercialised example is a maize variety that produces a heat-stable, starch-degrading enzyme in seeds. In Denmark, research is aimed at using straw for making bioethanol, where enzymes that can degrade cell walls are produced in the straw. These enzymes are first active when the temperature rises above 50° and therefore do not affect the plant's growth.

Safe production of medicine

For a number of years there has been intensive research into the use of plants to produce vaccines, antibodies, medication, diagnostics components and a number of different enzymes. It has been demonstrated that the plants are capable of synthesising and assembling even the most complicated compounds. A very large number of these components are currently undergoing tests. One example is insulin produced in a thistle. Another example is a plant that produces a protein needed for re-using vitamin B12.

The advantage of plant-based medicine production is that it will be considerably cheaper than conventional ways of producing the components. In addition, plant-based products have the advantage that they are definitely free of HIV, hepatitis and other viruses that are a problem when components in human blood are to be cleaned. Commercialising the products is a slow process despite such progress and advantages.

IV. Opinion formation and socio-economic benefits and risks

A considerable part of the GMO debate derives from the widespread scepticism and resistance towards GMOs in EU countries. People and politicians both express this scepticism, and the scepticism presumably plays an important role in the limited use of GM products in the EU's food production.

A number of studies have cast light on this scepticism in the form of opinion analyses. In an international perspective, the Eurobarometer surveys are some of the most important quantitative sources of knowledge on people's opinion towards gene technology. The Eurobarometer surveys have been conducted in the EU member states since 1991 at intervals of about three years and they have - apart from mapping the opinion to topical GM themes - included a number of questions that make it possible to describe the development in opinions. The most recently published Eurobarometer survey is from 2005; a survey from 2008 is expected to be published during the coming year. A number of individual quantitative surveys have been carried out in Denmark as well as in many other countries in addition to the Eurobarometer surveys.

In general, the picture painted by the surveys of people's opinions towards gene technology that have been conducted in Denmark as well as in the rest of Europe, shows that the opinions are closely related to whether people find the use of GM products and technology useful or not. There is no mention of gene technology being rejected as such, but typically that reservations are formulated in relation to the concrete use. A number of surveys indicate that three parameters are important to people's assessments of the individual technologies - benefits, risks and ethical (moral) questions.

The vehement protest against GM foods in e.g. 1996 can thus be seen as a protest against the focus on environmental and health risks and thus insufficient concern for socio-economic benefits and risks and moral/ethical questions.

Benefits for the individual does not legitimise the use of GMOs

Several studies indicate that socio-economic benefits is not a clear description, but that people differentiate between various forms of benefits, from self-interest over private or commercial benefits to broader benefits related to society as a whole. Much indicate that self-interest and commercial benefits are not enough to legitimise the use of gene technology among the broader population. What is important is the benefit of GM crops to society. Uses that can contribute to solving important societal problems dealing with e.g. hunger, illness and the environment are accepted to a far greater extent than uses that are aimed at making everyday life easier for the individual or that increase businesses' earnings.

This demand for socio-economic benefits can perhaps contribute to explaining the widespread resistance in Denmark and a number of other EU countries to hitherto introduced genetically modified food. In the eyes of the people, the uses of gene technology so far in the food area have predominantly been aimed at increasing the effectiveness of the food industry and farming - useful effects that fall outside the category socio-economic benefits. In this connection it should be noted that Danish surveys indicate that the currently most widespread GM used in farming, herbicide resistance, is often not categorised as societally useful. This may be because herbicide resistance, although it is supported by arguments of less pollution and increased biodiversity, continues a problematic technology - the use of pesticides.

On the other hand there seems to be a broader acceptance of agricultural uses with a clearer environmental or health-related purpose. But there is some scepticism towards uses with a health-related purpose where there are alternatives. For example, there seems to be a widespread feeling that health-related problems such as obesity should be treated through changes in diet and similar tactics rather than through contributions from controversial technologies such as gene technology.

It is in this light that one must see the relatively positive assessment of agricultural uses in the non-food areas that was for instance indicated by a Danish citizens' panel on genetically modified plants in 2005. The panel's acceptance of non-food uses is thus in line with earlier surveys, which showed that applications with a clear environmental or health-related benefits are acceptable.

How to calculate socio-economic benefits

The demand for socio-economic benefits raises a central question: How tocalculate the benefits. Chapter 8 reviews the criteria for computing the socio-economic benefits or welfare changes related to the introduction of GMOs in Danish agriculture. The analysis is based on a review of existing literature on the subject. The review includes Danish as well as European consumer opinions and preferences with regard to risks, uncertainties and willingness to pay in relation to GMOs in food.

Generally, Danes are the EU nationals who feel best informed on GM foods. At the same time, Danes are among the consumers who associate the lowest risks with GMO technology. According to an opinions survey, GMOs are regarded as considerably less risky than pesticides and diverse common additives in food. This indicates that Danish consumers will not be very negative towards the introduction of GM foods.

Danish consumers ask for informed choice

However, Danish consumers also express very poor faith in the authorities' ability to ensure that GM organisms will not lead to damage to the environment and human health. As many as 70% of Danish consumers want the possibility to choose between GM and non-GM products. This means that labelling will be a requirement. Experience from EU countries where GM products are on the market does not indicate that consumers here give much priority to differentiating between GM and non-GM products. In reality it is hardly possibly to get a definite understanding of Danish consumers' behaviour with regard to GM products before they have been launched on the Danish food market to any great extent.

With the scepticism that Danish consumers express regarding possible damage to both the environment and human health, one cannot assume that GM products can be launched in Denmark to any great extent at the moment without widespread scepticism among consumers. The existing computations must be considered as being too uncertain for them to be used to quantify the overall effect in economic terms. Experience from other countries indicates that the perceived risks will diminish in time – provided that no large damaging effects derive from the GM crops. However, no empirical basis exists for assessing whether or to what extent such acceptance will occur.

Appraisal of socio-economic costs and benefits in the decision-making process

The authorisation process for GMOs is described in chapter 2 of the fact report. It has often been said that GMOs' socio-economic criterias should be assessed in connection with the approval of the GMOs. Such an assessment could meet the above-mentioned demand for socio-economic benefits.

With regard to the present GMO legislation, the overall purpose of regulation is to ensure that cultivation and marketing of GMOs do not lead to undesired effects on the health of people and animals or the environment. The authorisation is primarily based on risk assessments, which among other things means that the socio-economic benefits and risks of a GM crop are not taken into account. The freedom to act of individuals (and businesses) can generally only be restricted by law on a scientific ground showing that the specific action can result in injury to others, including damage to the environment. Whether genetically modified crops represent a benefit will in the last resort depend on whether there is a market for them.

The authorisation procedure must respect ethical principles that are 'recognised' in a EU member state and, in addition, open up the possibility of gathering and involving opinions from ethics committees on general ethical aspects of biotechnology. Ethical considerations are here apparently defined as something that does not involve risks. It is difficult to imagine that a general ethical concern alone should be able to lead to a specific GM crop not being authorised if the risk assessment does not indicate problems.

Two models for taking socio-economic benefits and risks into account

Chapter 8 of the fact report describes two models for including socio-economic benefits and risks in the authorisation procedures.

One model proposes that authorisation must be based on an overall assessment of the genetically modified product under authorisation review with regard to expected benefits and risks. This implies that there is a weighing-up of risks in relation to the expected socio-economic benefits, which again, all things being equal, implies that the greater the expected benefits, the greater the risk that is acceptable. In other words: The greater the benefits, the greater the acceptance of potential disadvantages.

The other model adds further restrictions to the authorisations procedure. Apart from requiring that the genetically modified product under authorisation review represents the same low, acceptable risk level existing before it is authorised, it must also meet a requirement that it represents suitable, substantial benefit.

Both models can be said to clash with the tradition for free consumer and technology choices that is generally found in Denmark. If considerations on socio-economic benefits and risks are to be part of future authorisations, the authorities or the politicians must assume the role of moral judge in relation to which technologies can be marketed. Whether this is a good idea depends on a substantial political discussion.

Normally, behaviour-regulating motivation in the form of e.g. taxes is regarded as acceptable. To prohibit the marketing of products on the basis of a central assessment of what is good for the people or morally unacceptable is a very radical step.

In addition, turning ethical consideration into operational principles is difficult, not least because there can be disagreements on the relevant ethical assessment. What one person may perceive as e.g. an unacceptable intervention in nature's creative activities will be perceived by another as a technology completely without problems, on which it would be unacceptable to place religious-motivated limits. It would be difficult to take both ethical opinions into account at the same time.

Objectively, the authorities should authorise genetically modified organisms when they have been assessed as safe. The criterion for authorisation should be based on risks and nothing else. Nevertheless, socio-economic benefits and risk are also relevant when assessing the genetically modified organisms. A description of the socio-economic risk and benefits can help to clarify why use of the crop is interesting.

GMOs
- what´s in it for us?

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