MINISTRY OF AGRICULTURE
OF THE CZECH REPUBLIC

EXPERIENCE WITH BT MAIZE CULTIVATION IN THE CZECH REPUBLIC 2005–2009

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CONTENT

LIST OF ABBREVIATIONS

Bt	Bacillus thuringiensis
CISTA	Central Institute for Supervising and Testing in Agriculture
ECB	European corn borer
EP and C	European Parliament and Council
EU	European Union
FAO	Food and Agriculture Organisation (FAO number = hybrid maturity number)
FITA	Fixed intangible and tangible assets
GM	Genetically modified
GMO	Genetically modified organism(s)
SPA	State Phytosanitary Administration

1. INTRODUCTION

1.1. WHAT ARE GENETICALLY MODIFIED (GM) CROPS?

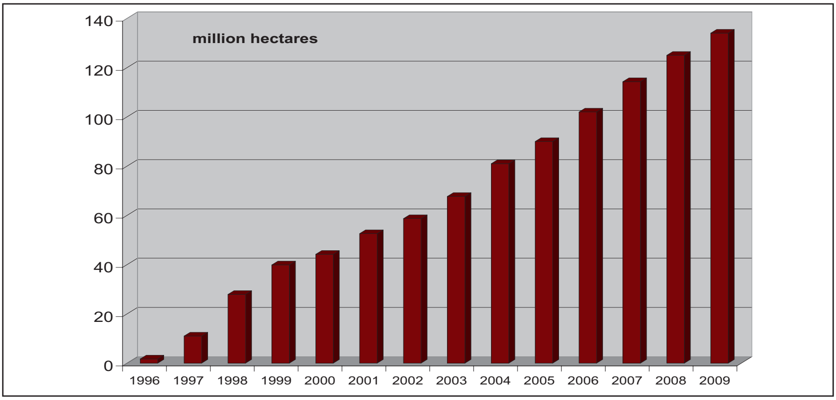
Genetically modified (hereinafter referred to as GM) crops are plants in which the hereditary material (DNA) has been altered with the aid of gene technologies. This concerns breeding methods (so-called genetic engineering) from the field of biotechnology, which uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use. Gene technologies allow for interspecies transfer of genes, although this does not concern introduction of artificially created genes. We also call GM crops transgenic crops.

GM crops are characterised by various specific traits, which especially include resistance to harmful biotic or abiotic factors – pests, diseases, cold, drought etc., and/or tolerance to spraying with non-selective herbicides, which destroy all other, undesirable plants (weeds). GM crops with the mentioned characteristics are above all of benefit to growers. The next generations of GM crops are expected to have also direct benefits to the consumer – e.g. GM crops with a higher content or better structure of nutrients or GM crops with anti-carcinogenic effects; or of benefit for sectors other than agriculture – e.g. edible vaccines, biodegradable plastics, substitution of fossil fuels, removal of environmental pollution etc.

1.2. HOW WIDESPREAD ARE GM CROPS IN AGRICULTURAL PRACTICE?

GM crops first appeared in worldwide statistics in 1996 with an area of approx. 1.7 million ha; in 2009, the global GM crops area reached the level of 134 million ha (see Graph no. 1.1.). GM crops thus became the fastest adopted cultivation technology in the world to date. In 2009, this technology was used by 14 million growers in 25 countries around the world. The most frequently cultivated crops are GM varieties of soya, maize, cotton and oil seed rape. Other GM plants produced in the world are sugar beet, papaya, squash, alfalfa, tomato, sweet pepper, poplar, carnation, blue rose, and petunia.

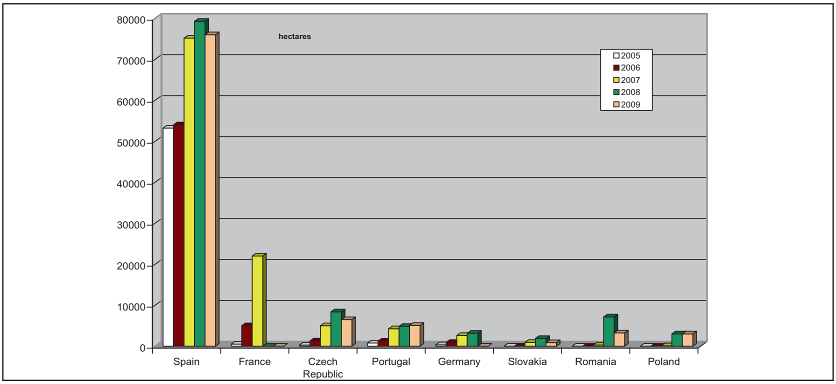
Graph no. 1.1. – Development of global GM crops area 1996–2009



Source: Statistics from the International Service for the Acquisition of Agri-biotech Applications (www.isaaa.org)

In the Czech Republic, respectively EU, commercial cultivation is only possible of such GM crops, which have undergone a strict approval procedure on the EU level. This includes, among other things, assessment of any possible risks of the GM crop for human and animal health and the environment. Czech growers can use such GM varieties which have been then recorded in the National Plant Variety Register in the Czech Republic or in the Common Catalogue of Varieties of Agricultural Plant Species in the EU. So far, only Bt maize type MON810 and since March 2010 also GM potatoes Amflora have been authorised for cultivation in the Czech Republic, respectively in the EU. In the European context, the Czech Republic ranks alongside another 7 EU countries which have practical experience in Bt maize cultivation; these are: Spain, France, Romania, Portugal, Germany, Poland and Slovakia (see Graph no. 1.2.). In past years, GM soya tolerant to non-selective herbicides was successfully cultivated in Romania. However, after accession to the EU in 2007, Romania had to completely abandon its cultivation (this GM crop is not authorised for cultivation in the EU).

Graph no. 1.2. – Development of Bt maize area in the EU 2005–2009



Sources: Ministries of Agriculture in EU member countries involved, European Commission, Agrafacts, www.transgen.de

1.3. WHAT PRECEDES AND WHAT FOLLOWS PLACING OF GM CROPS ON THE EU MARKET?

Before a GM crop finds its way to the growers' fields, it must undertake a very long journey, first of all on a scientific-research and breeding level and then through an approval, administrative procedure, specific for the EU. Development of a new GM crop and the approval procedure itself are very costly steps, a fact which is subsequently reflected in the need for patenting of such new crops by the subject, which launched them onto the market.

Binding legal regulations exist in the EU for GM organisms (hereinafter referred to as GMO), which determine the conditions for deliberate release of GMO into the environment and their placing on the market in the EU (especially Directive EP and C 2001/18/EC and Regulation EP and C 1829/2003/EC) and also measures for monitoring (monitoring plans) and labelling of GMO after their introduction onto the market (Regulation EP and C 1830/2003/EC). In terms of the approval procedure, the inventor and/or developer of the GMO submits a comprehensive application, in which, among other things, s/he provides detailed assessment of all potential risks for human and animal health and for the environment. Evaluation is made of toxicity, allergenicity, nutritional composition of the product, impact of the GMO on target and non-target organisms, biogeochemical processes, persistence and invasivity of the GMO in the environment etc.

The application is considered by the GMO panel of the European Food Safety Authority (EFSA), which issues a scientific opinion on it. This provides the basis for subsequent decision-making by the European Commission whether to propose the product for introduction onto the market or not. The member states then have the possibility to decide on placing on the EU market in the relevant committees of the European Commission, or in the EU Council by qualified majority. If this does not occur, the European Commission has the right to make a final decision on placing on the market.

In the Czech Republic, GM crops are considered by scientific and expert bodies, which especially include:

- Czech Commission for the Use of Genetically Modified Organisms and Genetic Products,
- Scientific Committee for Genetically Modified Food and Feed,
- Committee for the Use of Genetically Modified Organisms and Genetic Products at the Ministry of Agriculture of the Czech Republic.

However, risk assessment and management does not end on introduction of a GM crop onto the market. On the basis of a monitoring plan, the consent holder (e.g. Monsanto in the case of GM maize MON810) is obliged to perform monitoring of potential impacts, whether these were already identified during the approval procedure (case-specific monitoring), or even those, which were not anticipated (general surveillance). Every year, the consent holder submits a report on monitoring to the European Commission and relevant member countries. In the event of any new information being ascertained on the impact of the GM crop on human health or the environment, the monitoring plan may be adapted or if there is any risk of negative effects, the consent for placing of the crop on the market may be withdrawn. However, no case of any threat of negative effects and subsequent withdrawal of a consent has so far been recorded.

1.4. WHAT IS COEXISTENCE OF GM CROPS WITH CONVENTIONAL AND ORGANIC AGRICULTURE?

Monitoring of GM crops after their placing on the market is based on the precautionary principle, which is applied to these crops in the EU. In agricultural practice, this principle is manifested by the necessity to handle the GM crop separately from other production even after approval and declaration as being as safe as its conventional form and also to further monitor it throughout the whole production chain. In the first step, this requires cooperation by growers in such a way as to ensure the concurrent existence (= coexistence) of all available production systems, and that the products from these systems are not mixed over an established threshold. A tolerance limit of 0.9% has been set for accidental or technically unavoidable mixture of GMO in conventional products or organic products in terms of Regulation EP and C 1829/2003/EC.

In the wider sense of the word, coexistence can be understood as the possibility of growers to choose between conventional production, organic production and production based on transgenic crops. Subsequently, there is also the possibility for the consumer to choose between different products and possibly to support a specific type of cultivation system through his or her choice. In order to ensure these objectives, it is recommended in EU member countries that specific rules be introduced for GM crops cultivation, the so-called coexistence rules. It must be emphasised that this does not concern rules, which should ensure the safety of products or reduce the health risk and risk for the environment in terms of cultivation – these matters are already resolved in the approval procedure for placing of GMO on the market.

The aim of coexistence rules is to determine measures to minimise potential economic losses, which could be created through admixtures of GMO in conventional or organic products. These rules are of a preventative nature and contribute towards none of the systems of agricultural production in the Czech Republic (conventional, organic or with the use of GM crops) being excluded, and thus for the possibility to be left open for farmers and subsequently also consumers to choose from any of the above-mentioned systems.

1.5. WHICH RULES AND ADMINISTRATION RELATE TO GM CROPS CULTIVATION?

Binding coexistence rules exist in the Czech Republic for growers of GM crops in the form of mandatory obligations. These obligations especially result from Recommendation of the European Commission no. 556/2003. The fundamental legal regulations in the Czech Republic in this respect are:

- Act no. 252/1997 Coll., on Agriculture, as amended by Acts no. 441/2005 Coll. and Act no. 291/2009 Coll.,
- Executive Decree no. 89/2006 Coll., on more detailed requirements for the cultivation of genetically modified variety, as amended by Decree no. 58/2010 Coll.,
- In part Act no. 78/2004 Coll., on the use of genetically modified organisms and genetic products, as amended by Act no. 346/2005 Coll., specifically Section 11 (labelling of GM organisms and their products) and Section 23 (notification of GM crops locations),
- Regulation EP and C no. 1829/2003, on genetically modified food and feed,
- Regulation EP and C no. 1830/2003, concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC.

On the basis of the above-mentioned regulations, GM crop growers must comply with set binding obligations. Every GM crop grower in the Czech Republic is, among other things, obliged to inform about his intention of growing GM crops, in such a way that this information is available to neighbouring growers in advance, and subsequently to notify actual sowing of such crops also to the appropriate state administration authorities. Coexistence measures also react to the natural character of plants to disseminate their genetic material (especially via pollen) into their surroundings. This is why certain crop-specific minimum isolation distances have been established between GM and non-GM crops of the same species. Minimum isolation distances may be replaced by a buffer zone – a barrier around the GM crop – made up of the same, but non-GM crop. The grower must also keep records relating to all handling of the GM crop and its product and must keep these records for a minimum of 5 years. A key coexistence measure is labelling of the harvested product as GMO if this product is further introduced into the production chain and not used by the grower directly on the farm e.g. for feeding of farm animals or for production of bio gas or ethanol.

It is evident from the above-mentioned list of rules that GM crops cultivation in the Czech Republic is accompanied by increased administration, when in the first phase this concerns the obligation to provide written notification to state administration authorities – the Ministry of Agriculture and the Ministry of the Environment of the Czech Republic. In the second phase, it is then necessary to keep written records with basic data on cultivation of GM crops (from purchasing of seeds, sowing and harvesting of GM crops, right through to sale or other processing of the harvested product) and especially to provide the information during sale that this concerns a GM organism.

1.6. WHAT IS BT MAIZE AND THE EUROPEAN CORN BORER (ECB)?

By the end of 2009, the only GM crop that had been released for commercial cultivation in the Czech Republic was Bt maize resistant to insects pests. Bt maize is transgenic maize, which has had a gene originating from ***B**acillus **t**huringiensis* bacteria introduced into its genetic material. This gene codes production of protein with a toxic effect on certain insect species. Bt maize MON810 is specifically targeted at insect pests from the order of Lepidoptera (butterflies and moths), the caterpillars of which feed on maize plants. In the Czech Republic, this especially concerns the European corn borer (*Ostrinia nubilalis*), hereinafter referred to as ECB.

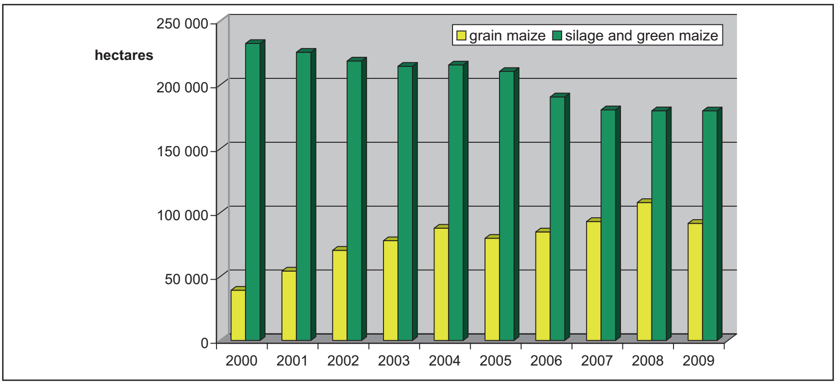
In the Czech Republic, ECB has one generation per year with an occasional occurrence of two generations, but in Southern Europe it may have up to three generations per year. Adults (see Figure 1.1.) emerge from the first half of June until August in several waves and gradually deposit eggs in collections of 10 – 30 eggs on the underside of the leaves. The harmful stage of ECB ontogenesis is the larvae (see Figure 1.2.), which feeds on the core of the stalks, cobs and grains. Infested plants frequently break or suffer from lodging, which leads to yield losses. Bore holes from caterpillar feeding are secondarily infested by plant pathogens, especially fungi from the genus *Fusarium*, which produces mycotoxins dangerous for human and farm animals health, and thus impairs the quality of the harvested product.

Fig. no. 1.1. and 1.2. – Adult and larvae of the European corn borer

Photo: Jakub Beránek, State Phytosanitary Administration

In the Czech Republic, the ECB occurs most frequently in the warmest regions, i.e. in Southern Moravia and Central Bohemia. However, its density has increased in the Czech Republic in last years. The danger of maize being infested by ECB is continuously increasing (with a view to annual variability). The impact of ECB damage is more notable in the case of maize cultivated for grain. The significant increase in the area of grain maize to the detriment of silage maize has also had an effect on the increase of ECB damage in recent years (see Graph no. 1.3.). Detailed information about the current ECB flight activity in the territory of the Czech Republic can be found on the website of the State Phytosanitary Administration: http://www.srs.cz/pas/mury. Except for maize, ECB have other approx. 200 host plants from various families, including several agricultural crops such as hops or potatoes.

Graph no. 1.3. – Development of areas with grain maize and silage (+ green) maize in the Czech Republic 2000–2009



Source: Czech Statistical Office

There are some scientific research projects focused on Bt maize in the Czech Republic which are performed for example by the Institute of Entomology at the Biological Centre of the Academy of Sciences of the Czech Republic in České Budějovice (www.entu.cz), the Crop Research institute in Prague (www.vurv.cz) or the Faculty of Agrobiology, Food and Natural Resources at the Czech University of Life Sciences in Prague (www.af.czu.cz – Department of Agroecology and Biometeorology).

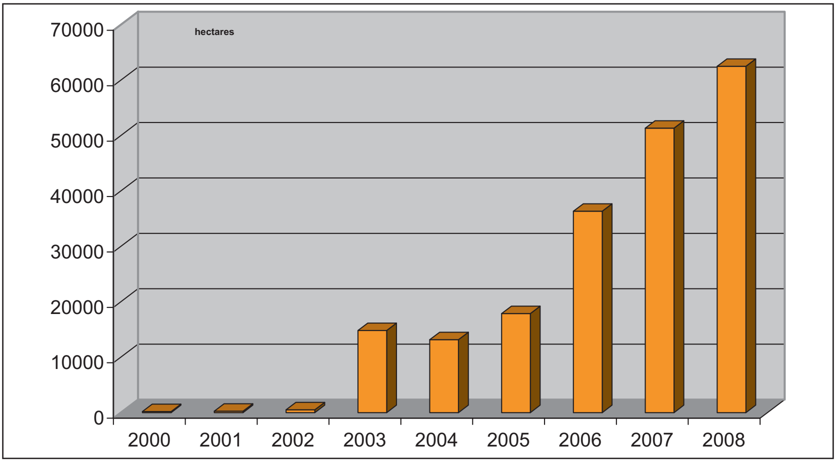
Further information about the Czech biosafety issue (incl. GMOs) in English version you can find on the websites of Biosafety Clearing House: http://www.mzp.cz/www/webdav biosafety.nsf/biosafety/index.html.

1.7. HOW TO CONTROL ECB? THE SIGNIFICANCE OF BT MAIZE

To control ECB, it is possible to use registered chemical insecticides on the basis of pyrethroids or agents, which are selective to natural enemies of pests, from the group of growth regulators (e.g. Nomolt 15SC), from the group of insect hormone analogues (e.g. Integro) and from the group of agents with a specific effect (e.g. Steward). Regarding the biological control, we can use methods based on *Bacillus thuringiensis* spp. kurstaki or parasitic wasps from the genus Trichogramma. With a view to the level of effectiveness and also costs for treatment, farmers prefer synthetic insecticides; from this point of view, environmentally-friendly biological protection is a less effective and relatively costly affair. Direct protection of maize and its efficiency is strongly dependent on precise indication of pest flying activity.

Increasing share of grain maize in the total maize area and increasing ECB occurrence in the Czech Republic have been reflected in a growth in the acreage chemically treated against ECB (see Graph no. 1.4.). Since 2000, when maize treatment concerned only hundreds of hectares, the area of maize treated with synthetic insecticides has increased to more than 60,000 hectares. Although the maize area which is chemically treated against ECB has a tendency to grow, for the time being it represents less than a quarter of the total maize area in the Czech Republic. To a certain extent, this is also caused by the varying intensity of ECB occurrence and harmfulness, when in 2003 to 2006 its occurrence was high and in 2007 and 2008 medium to low.

Graph no. 1.4. – Maize areas treated with synthetic insecticides to control ECB in the Czech Republic in 2000–2008



Source: State Phytosanitary Administration

An alternative method for maize protection against ECB is cultivation of Bt maize. Bt maize de facto creates its own insecticide and thus it is not necessary to use additional chemical or biological protective agents, as Bt hybrids have so far shown high effectiveness against ECB in our country. When cultivating Bt maize, production costs are decreased as are harvesting losses. During the vegetation, the tall growing crop is also not damaged by spraying machines. Cultivation of Bt hybrids thus leads to savings on finances and materials, work and energy, which can help to increase the overall economic profitability of maize production in comparison to cultivation of conventional hybrids treated with protective agents to control ECB.

2. OVERVIEW OF BT MAIZE CULTIVATION IN THE CZECH REPUBLIC IN 2005–2009

Bt maize cultivation in the Czech Republic first began in 2005. A record of Bt maize areas was made in this year by the State Agricultural Intervention Fund because the conditions for its cultivation were part of the system for receiving national additional payments per agricultural area. With a view to the fact that this was the first trial year, both for growers and also for the state authorities, certain inaccuracies occurred when registering areas (and subsequent distortion of the total net area of Bt maize) in the first year of cultivation. The originally stated information – 270 ha of total area included some buffer zones implemented around Bt maize with conventional hybrids. For the purposes of this publication, we consulted the growers concerned and adjusted figures to only include the net area sown with Bt maize. Since 2006, areas with Bt maize have been registered by the Ministry of Agriculture via regional agencies for agriculture and the countryside (formerly agricultural agencies). The total Bt maize areas are rounded off to whole tens of hectares for the sake of clarity and simplicity. A detailed acreage is stated in the text below in Table no. 2.4.

Fields of scientific research sites, which performed trial cultivation of Bt maize or other GM types of maize in 2005–2009 in the regime of deliberate release into the environment were excluded from the statistics for subsequent analysis. This was done due to their non-commercial character and negligible acreage.

In 2005, when it was first possible to sow GM crops for commercial purposes in the Czech Republic, 150 ha (net areas without buffer zones) of Bt maize were recorded. The first 51 growers tried out this new crop on smaller, trial areas (see below). In subsequent years until 2008, significant growth occurred in areas, which gradually increased by 760%, 288% and 68% respectively. Accordingly, the number of growers of Bt maize also increased. In 2009, a drop in areas and the number of growers occurred for the first time with a view to problematic sale of Bt maize products or even animal products derived from animals fed with Bt maize. See Table no. 2.1.

Table no. 2.1. – Development of the number of growers and total Bt maize areas in the Czech Republic in 2005–2009

	2005	2006	2007	2008	2009
Total Bt maize area (ha)	150	1,290	5,000	8,380	6,480
Year-on-year change (%)	-	760	288	68	-23
Number of Bt maize growers	51	82	126	167	121
Year-on-year change (%)	-	61	54	33	-28

Sources: Ministry of Agriculture of the Czech Republic, State Agriculture Intervention Fund

If we follow the share of Bt hybrids in the total maize areas in the Czech Republic, we see that it remains marginal – it was greatest in 2008 when areas with Bt maize reached a level of just under three percent of the total maize area in the Czech Republic (see Table no. 2.2.).

Table no. 2.2. – Share of Bt maize areas in the total maize area in the Czech Republic in 2005–2009

	2005	2006	2007	2008	2009
Total maize area in the Czech Republic (ha)	290,546	275,500	273,546	287,676	271,273
Bt maize area (ha)	150	1,290	5,000	8,380	6,480
Share of Bt hybrids in the total maize area (%)	0.05	0.47	1.83	2.91	2.39

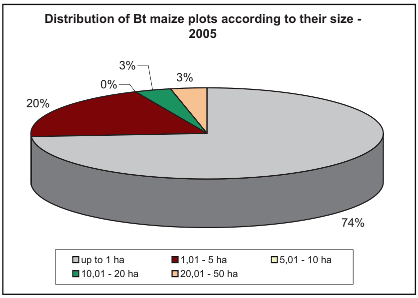
Sources: Czech Statistical Office, Ministry of Agriculture of the Czech Republic, State Agriculture Intervention Fund

2.1. DEVELOPMENT OF AREAS AND NUMBER OF GROWERS

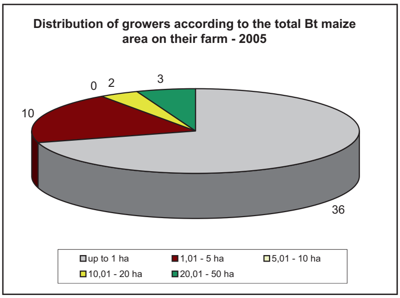
In the first year 2005, Bt maize was cultivated by 51 growers on 61 fields on a total area of 150 ha in the Czech Republic.

From these 61 fields, almost ¾ had an area of up to 1 ha (Graph no. 2.1.), which can be indicated as cultivation of a trial nature (trying out new varieties and technology). From the point of view of growers, 36 (70%) sowed Bt maize on an area of up to 1 ha and 3 already decided in the first year to sow larger production areas of Bt maize with an area between 20 and 50 ha (Graph no. 2.2.). The largest area was 40 ha.

Graph no. 2.1.



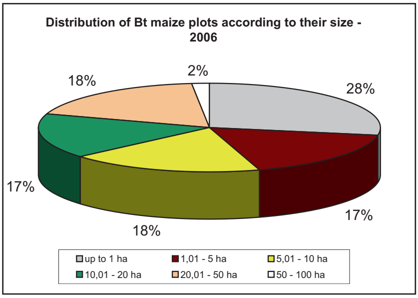
Graph no. 2.2.



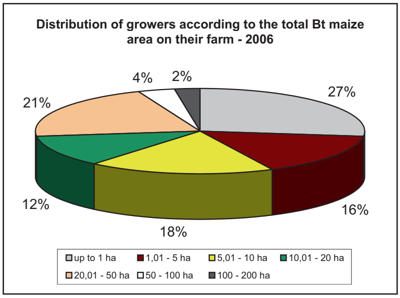
In 2006, Bt maize was cultivated by 82 growers on 115 fields on a total area of 1,290 ha in the Czech Republic.

From these 115 fields, 28% had an area of up to 1 ha (Graph no. 2.3.), i.e. there was a drop in the number of trial areas compared to the previous year and a growth in larger production areas of Bt maize; plots with an area of more than 50 ha were sown for the first time. The largest plot was 75 ha; the largest grower of Bt maize registered a total of 126 ha of this crop on the farm. Approximately ¼ of growers sowed Bt maize on more than 20 ha (Graph no. 2.4.).

Graph no. 2.3.



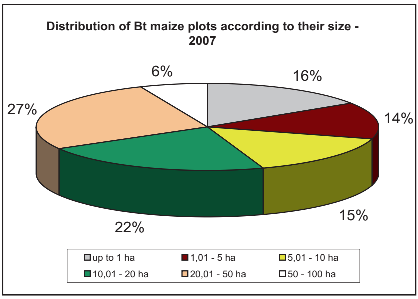
Graph no. 2.4.



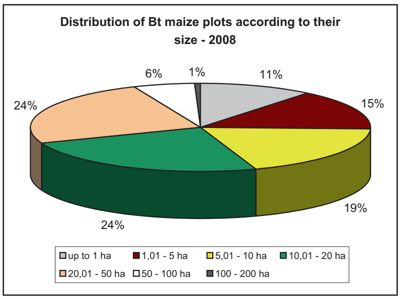
In 2007, Bt maize was cultivated by 126 growers on 286 fields on a total area of 5,000 ha in the Czech Republic.

From these 286 fields, 16% had an area of up to 1 ha (Graph no. 2.5.), i.e. there was again a drop in the number of trial areas compared to the previous year and a growth in larger production areas of Bt maize; 1/3 of plots had an area of more than 20 ha. The largest plot had an area of 100 ha; the largest grower of Bt maize registered a total of 373 ha of this crop on the farm. Almost half the growers sowed Bt maize on more than 20 ha (Graph no. 2.6.). For the first time, there were 4 growers who sowed more than 200 ha of Bt maize on the farm.

Graph no. 2.5.



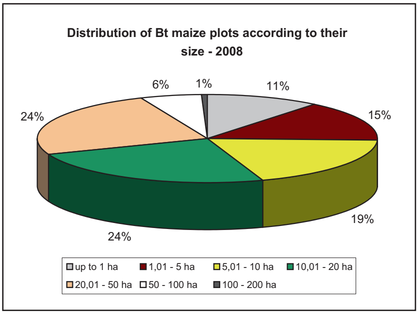
Graph no. 2.6.



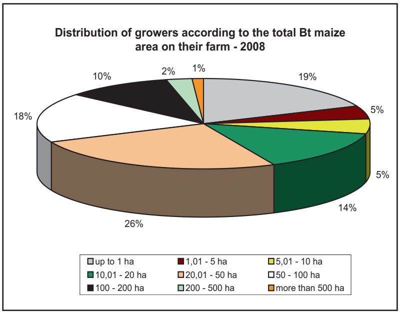
In 2008, Bt maize was cultivated by 167 growers on 482 fields on a total area of 8,380 ha in the Czech Republic.

From these 482 fields, 11% had an area of up to 1 ha (Graph no. 2.7.), i.e. there was again a drop in the number of trail areas compared to the previous year and a growth in larger production areas of Bt maize. 31 % of plots had an area of more than 20 ha, i.e. there was a slight drop in the number of these areas compared to the previous year. The largest plot had an area of 123 ha; the largest grower of Bt maize registered a total of 562 ha of this crop on the farm. 57% of growers sowed Bt maize on more than 20 ha (Graph no. 2.8.); 2 growers sowed Bt maize on a total area of more than 500 ha on the farm.

Graph no. 2.7.



Graph no. 2.8.



In 2009, Bt maize was sown by 121 growers on an area of 6,480 ha. I.e. for the first time, there was a drop in the areas used for cultivation of Bt maize and the number of growers of this crop.

Since 2005, when Czech growers gained the possibility of using Bt technology in practice, a total of 255 growers (+ 4 research subjects) have tried out this new method of protection against ECB. 44% of growers have one-year, 21% two-year, 16% three-year and 13% four-year experience. 14 growers have already cultivated Bt maize for 5 years, i.e. continuously since 2005. See Table no. 2.3. From these 14 growers, 4 of them have more or less remained with small trial areas of Bt maize.

Table no. 2.3. – Length of experience of Czech growers with Bt maize cultivation

	1 year	2 years	3 years	4 years	5 years	Total
Number of growers	113	53	42	33	14	255
% of growers	40.3	20.8	16.5	12.9	5.5	-

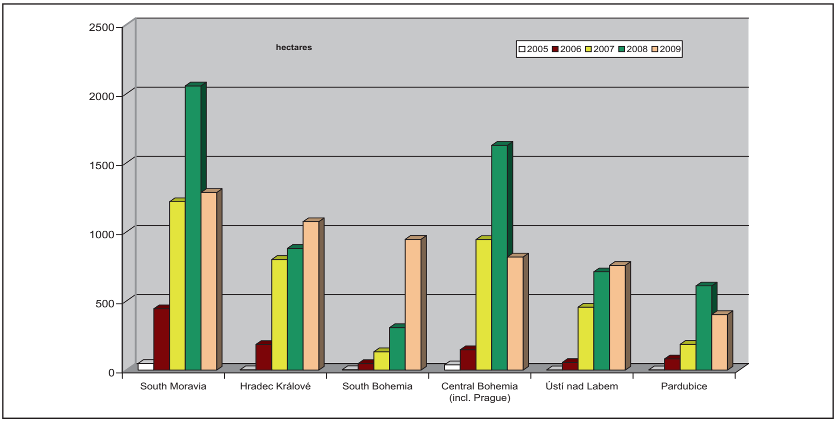
Sources: Ministry of Agriculture of the Czech Republic, State Agriculture Intervention Fund

2.2. REGIONAL DISTRIBUTION OF AREAS

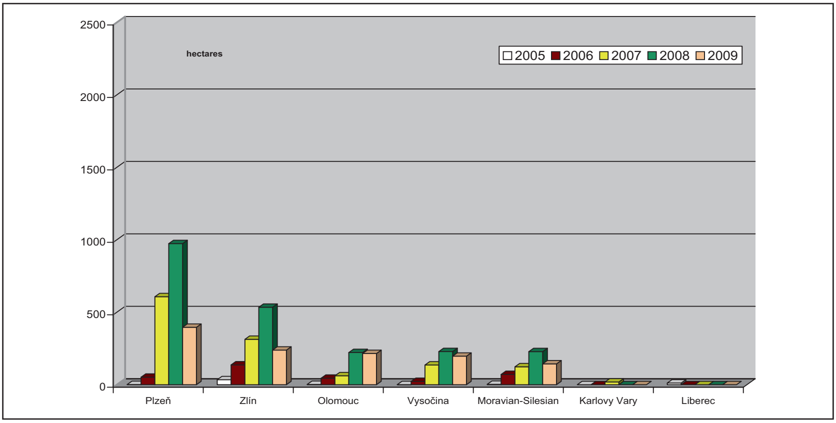
A key characteristic of Bt maize is its resistance to ECB. This is why Bt maize fields in the Czech Republic are especially to be found in areas where ECB causes economic damage when conventional hybrids are cultivated. If we compare maps of the occurrence and damage caused by ECB with maps of areas where Bt maize is cultivated in subsequent years, we find that in many cases there is a growth in Bt maize areas where a higher occurrence of the pest was recorded (see Appendix). From a nationwide point of view, it can then be stated that despite the fact that in the beginning (2005 and 2006), a larger part of Bt maize areas we found in Moravia, in later years and in relation to the ECB occurrence, the region of Bohemia was already significantly predominant in terms of overall areas (Table no. 2.4.).

From a regional point of view, a dominant position was assumed right from the very beginning of Bt maize cultivation by the Region of South Moravia, followed by the Region of Central Bohemia (including Prague), the Plzeň Region and the Hradec Králové Region. On the contrary, the least Bt maize is cultivated in the Liberec Region and the Karlovy Vary Region. See Graphs no. 2.9.1. and 2.9.2.

Graph no. 2.9.1. – Regional distribution of Bt maize areas in the Czech Republic in 2005–2009 – Part I



Graph no. 2.9.2. – Regional distribution of Bt maize areas in the Czech Republic in 2005–2009 – Part II



There has been a continuous growth in the Bt maize area since 2005 in three regions – Hradec Králové, South Bohemia and Ústí nad Labem; areas increased in other regions in 2005 – 2008, although they did decrease in 2009. A specific case is represented by the Liberec Region and Karlovy Vary Region, where Bt maize was cultivated only rarely over the course of 2005–2009.

Table no. 2.4. – Bt maize areas according to region in the Czech Republic in 2005–2009

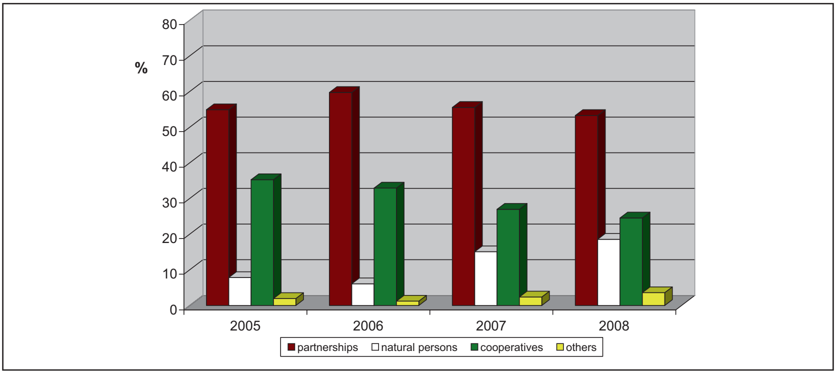
area (ha)	2005	2006	2007	2008	2009
South Bohemia	**4.02**	**48.02**	**133.09**	**307.86**	**946.81**
year-on-year change in %	-	1,095	177	131	208
South Moravia	**48.86**	**444.06**	**1,218.78**	**2,057.09**	**1,285.25**
year-on-year change in %	-	809	174	69	-38
Karlovy Vary	**0**	**0**	**18.58**	**0**	**0.02**
year-on-year change in %	-	-	-	-	-
Hradec Králové	**3.26**	**186.23**	**800.71**	**881.36**	**1,074.27**
year-on-year change in %	-	5,813	330	10	22
Liberec	**11.44**	**0**	**0**	**0**	**0**
year-on-year change in %	-	-	-	-	-
Moravian-Silesian	**2.62**	**70.71**	**123.60**	**228.18**	**143.69**
year-on-year change in %	-	2,599	75	85	-37
Olomouc	**1.80**	**44.56**	**61.53**	**221.83**	**215.15**
year-on-year change in %	-	2,376	38	261	-3
Pardubice	**2.60**	**81.21**	**187.45**	**609.60**	**402.21**
year-on-year change in %	-	3,023	131	225	-34
Plzeň	**1.00**	**51.62**	**607.16**	**973.62**	**396.20**
year-on-year change in %	-	5,062	1,076	60	-59
Central Bohemia (incl. Prague)	**38.49**	**147.78**	**944.72**	**1,626.54**	**819.16**
year-on-year change in %	-	284	539	72	-50
Ústí nad Labem	**1.99**	**56.42**	**456.17**	**711.36**	**758.01**
year-on-year change in %	-	2,735	709	56	7
Vysočina	**0.22**	**22.8**	**135.94**	**228.48**	**196.79**
year-on-year change in %	-	10 364	596	168	86
Zlín	**34.42**	**136.48**	**313.12**	**534.41**	**238.58**
year-on-year change in %	-	297	129	71	-55
Bohemia – total	**63.02**	**594.08**	**3,283.83**	**5,338.82**	**4,593.47**
year-on-year change in %	-	843	453	63	-14
share in the Czech Republic in %	42	46	66	64	71
Moravia – total	**87.70**	**695.81**	**1,717.03**	**3,041.51**	**1,882.67**
year-on-year change in %	-	693	147	77	-38
share in the Czech Republic in %	58	54	34	36	29
Total	**150.72**	**1,289.89**	**5,000.86**	**8,380.33**	**6,476.14**
year-on-year change in %	**-**	**756**	**288**	**68**	**-23**

The fastest growth rate of Bt maize areas was recorded in the Vysočina Region between 2005 and 2006, where the area increased by more than 100x. In general, the fastest growth rate was recorded in individual regions between the first and second year of cultivation, when growers moved on from their first, trial experience to real production usage of Bt maize. In later years, Bt maize areas then increased most in the Plzeň Region – approx. 12x greater area in 2007 than in 2006, as well as in the Ústí nad Labem Region – in 2007, 8x more Bt maize than in 2006 and in the Region of Central Bohemia – approx. 6x greater area in 2007 compared to 2006. On the other hand, the greatest decrease in areas was recorded in 2009 in the Plzeň Region (by almost 60%) and in the Zlín Region (by 55%). See Table no. 2.4

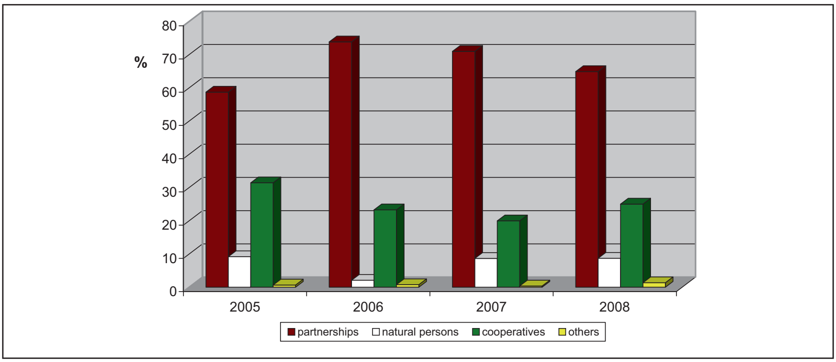
2.3. DISTRIBUTION OF GROWERS BY LEGAL FORM

If we look at Bt maize cultivation from the point of view of growers, it can be stated that all main legal forms are represented – legal persons (partnerships and cooperatives), natural persons and other types of entities (school farms, agricultural and vocational schools, universities and similar). Since the very beginning of Bt maize cultivation in the Czech Republic, a dominant position has been maintained by partnerships, followed by co-ops, natural persons and other entities (see Graph no. 2.10.). From the point of view of total Bt maize area cultivated by various entities, the position of partnerships is even more pronounced (see Graph no. 2.11.).

Graph no. 2.10. – Distribution of Bt maize growers by legal form in 2005 – 2008



Graph no. 2.11. – Distribution of Bt maize areas by legal form of growers in 2005 – 2008



If we look at the individual years, we see that partnerships always represented more than half of all entities cultivating Bt maize (52 – 60% in 2005–2008); Bt maize area operated by partnerships even reached a level of almost ¾ of all Bt maize areas in 2006. In 2005, co-ops made up more than 1/3 of all entities cultivating Bt maize, although this share decreased to ¼ in 2008. In 2008, almost 1/5 of growers were natural persons and their share has been increasing every year since 2006. However, this trend has not been projected into the share of plots sown by natural persons, as these sow 9% of the total Bt maize area in the Czech Republic every year (with the exception of 2006 – 2% of areas). Co-ops sow at least a fifth of the Bt maize area every year; in the first year, this concerned a share of almost a third of the total Bt maize area.

The largest Bt maize area in 2008 was sown by partnerships; the top ten of the largest growers included 2 co-ops, 1 natural persons and 7 partnerships.

3. SURVEY AMONG CZECH BT MAIZE GROWERS FROM THE FIRST 3 YEARS OF CULTIVATION

Ministry of Agriculture of the Czech Republic performed a questionnaire survey in 2006–2008 among Bt maize growers in such a way as to gain feedback for evaluation of the first three years (2005–2007) of practical experience with the new cultivation technology based on GM crops.

3.1. SURVEY METHODOLOGY

All 52 growers (including research subjects) growing Bt maize in 2005 were contacted at the beginning of 2006. A total of 47 growers answered the brief questionnaire, which meant a 90% rate of return. Selected growers with a larger Bt maize area in 2006 and 2007 were contacted over the next two years. The rate of return on the questionnaires was 75% and 77% respectively. Feedback provided by growers included 97% (in 2005) and 87% (in 2006 and 2007) of total Bt maize area (see Table no. 3.1.).

Table no. 3.1. – Indicators of the representativeness of the questionnaire surveys carried out among Bt maize growers

season investigated	no. of contacted growers (total no. of growers)	answered (no. of growers)	rate of return	representation of Bt maize growers	representation of Bt maize areas
2005	52 (of 52)	47	90 %	90 %	97 %
2006	45 (of 82)	34	75 %	41 %	87 %
2007	92 (of 126)	71	77 %	56 %	87 %

The survey was performed in an anonymous way, i.e. no identification details were required from the growers. Despite this, most growers (2005 – 66%, 2006 – 62% and 2007 – 58%) did state their identification details and sometimes also contact details voluntarily.

It can thus be stated that the Czech growers were interested in providing information about their experience with new technologies, and in doing so significantly contributed towards a high level of representativeness of the statistical data stated hereinafter.

Especially the following information was ascertained in terms of the questionnaire survey:

- advantages and disadvantages of Bt maize growing
- use of Bt maize, possible problems with sales
- crop yields achieved with Bt maize in comparison with conventional hybrids
- level of fungal infection in Bt maize in comparison with conventional hybrids
- regular methods of treating conventional maize against ECB on the farm
- possible local effects of Bt maize cultivation on the environment etc.

3.2. ADVANTAGES AND DISADVANTAGES OF BT MAIZE CULTIVATION

Growers were asked, in terms of the questionnaire survey, to identify the advantages and disadvantages when cultivating GM crops. Individual answers by growers were associated into groups of a similar character and considered jointly.

As far as the positive side of cultivating GM crops was concerned (see Table no. 3.2.), growers state advantages of a technological, qualitative, economical and environmental character. Advantages of the technology itself are most frequently mentioned – ranging from the simplicity and reliability of the protection against ECB and decrease in the production inputs, right through to the positive effect during harvesting (crops that are not broken or lodged). Advantages of a technological character were especially welcomed in the first year of cultivation (70% of growers), as this concerned the first practical verification of the advertised advantages in practice. In later years, advantages of a qualitative nature came to the forefront, when growers appraised the resulting effect of the new technology – a healthy crop and raw material for further utilisation. Another important aspect is the economic side of the new technology, which is mentioned by approx. 1/3 of growers. The environmental aspects of cultivating GM crops are also coming more and more to the forefront, in accordance with the general orientation and objectives of European agriculture, when Bt maize growers point out the benefits for the environment.

Apart from the above-mentioned advantages, few interesting answers were given in isolated cases, such as less (or zero) damage by wild boar, better resistance to or natural suppression of ECB (*note: on the contrary, the European consumer in many cases views GM crops as unnatural*). Since 2006, the percentage of growers who were not able to identify any disadvantages of the new technology has dropped. This can be explained by a slight decrease in the initial enthusiasm regarding the results achieved, and greater attention is devoted to the reverse side of the new technology.

Table no. 3.2. – ADVANTAGES of Bt maize cultivation

character of the advantage + percentage of growers mentioning this kind of advantage	List of answers as stated by growers
technological 2005 – **70** % of growers 2006 – **59** % 2007 – **38** %	effective/reliable protection against ECB no ECB infestation/no need to deal with this minimum/less ECB infestation no chemical protection no need for mechanisation (in tall growing crops) easy/simple agricultural machinery/protection undamaged plants/crops not lodged/uniformed growth simple harvest/no harvest losses no need to monitor pests elimination of the risk of unsuitable treatment date no spraying damage longer vegetative period /stay green effect less need to enter crop fields
qualitative 2005 – **26** % of growers 2006 – **47** % 2007 – **48** %	good/better/excellent/superb state of crop health vital plants/well-developed cobs healthy cobs not infested by fusaria not/less infested by fungal diseases no mycotoxins/less prone to mycotoxin infection better quality/hygienically healthy feed reduction of the occurrence/lower content of fungi (in feed) healthier product/maize/raw material for food better quality silage/superb state of health of silage more uniformed silage very good quality of preserved wet grain healthy animals and milk
economic 2005 – **17** % of growers 2006 – **32** % 2007 – **35** %	higher/good/above-average/superb yield (grain) lower/smaller costs (for treatment) savings on people/work/chemicals higher productivity of work lower losses
environmental 2005 – **6** % of growers 2006 – **9** % 2007 – **14** %	lower environmental burden no synthetic insecticides/no chemicals
other advantages mentioned only rarely	less/zero damage by wild boar better resistance to drought natural ECB suppression certainty of a good harvest
don't see any disadvantages	2005 – **9** growers, 2006 – **3**, 2007 – **3**

Table no. 3.3. shows and associates into groups according to similarity of character, the disadvantages mentioned by the growers themselves when cultivating Bt maize. There is a significant predominance of dissatisfaction among growers with the legislative-administrative background. Certain growers have resigned themselves to the specific rules for cultivation of GM crops, others regard them as completely pointless or at the very least a burden. From an economic point of view, growers identify on the one hand the disadvantages on production input, i.e. more expensive seeds for Bt maize hybrids, but on the other hand, also (and more frequently) mention economic problems on production output. Fears still persist and there is unwillingness on the part of customers to buy the Bt maize products, but also for example animal products (especially milk) from animals, which were fed with Bt maize. These problems are indirectly related to other disadvantages of a social character, which the growers state – general aversion to GMO (especially in the case of European consumers) and negative publicity in the EU. In isolated cases, some growers see no advantages of cultivating Bt maize at all.

Table no. 3.3. – DISADVANTAGES of Bt maize cultivation

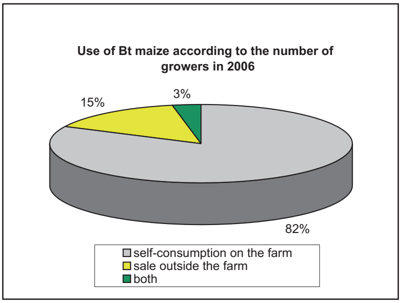
character of the disadvantage + percentage of growers mentioning this kind of disadvantage	List of answers as stated by growers
legislative administrative 2005 – **32** % of growers 2006 – **50** % 2007 – **41** %	extensive/far-fetched/needless/excessive/undue administration filling in of an unreasonable amount of questionnaires bureaucratic burden notification duty binding/pointless measures for GM crops cultivation more demanding records, problems with records labelling of GM crops and their products (complicated) legislation/administration checks (by state authorities) more complicated regulations sanctions in the event of mistakes being made
economic 2005 – **11** % of growers 2006 – **41** % 2007 – **24** %	higher/high price of seeds/Bt hybrids very expensive limited use of production/unsaleability/problems with sales limited number of buyers unwillingness/fears on the part of customers worse sales – not until warehouse capacity is free higher administrative costs loss-making technology overall little difference in yield
technological 2005 – **11** % of growers 2006 – **18** % 2007 – **6** %	more labour-intensive when sowing/cleaning machinery and equipment more complicated organisation of work selection of plots more complicated management of crop rotation separate harvesting/manipulation/drying spatial isolation/buffer zones later ripening /hybrids with higher FAO number/higher moisture level
other disadvantages mentioned only rarely	general aversion to Bt technology negative view of consumers regarding GMOs negative publicity in Europe increased susceptibility to smuts
don't see any advantages	2005 – **2** growers, 2006 – **2**, 2007 – **1**

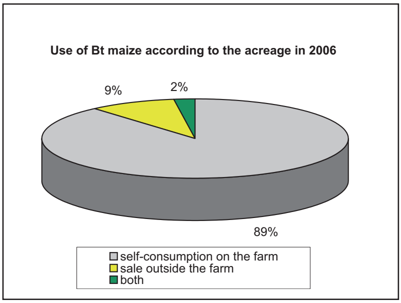
3.3. USE OF BT MAIZE

According to information from growers gained in terms of the questionnaire survey, most harvested Bt maize is used as feed for farm animals, especially in form of self-consumption on the farm. Part of production is also determined for industrial use as a raw material for bioethanol or biogas production. Bt maize is not used in food industry in the Czech Republic.

In the first year of cultivation (2005, 150 ha) almost all Bt maize was used as feed on the farm (1 plot was ploughed and Bt maize from another plot was used for bioethanol production). In 2006, 15% of growers (with the corresponding Bt maize area of 9%) stated that the harvested Bt maize was intended for subsequent sale and 3% of growers (2% of Bt maize area) combined sales and self-consumption on the farm (see Graphs no. 3.1. and 3.2.).

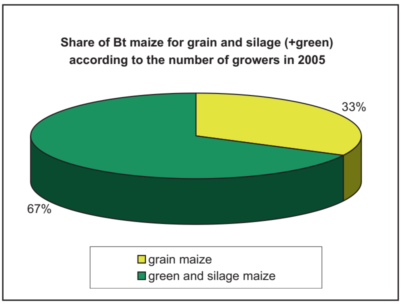
Graphs no. 3.1. and 3.2. – Use of Bt maize in 2006

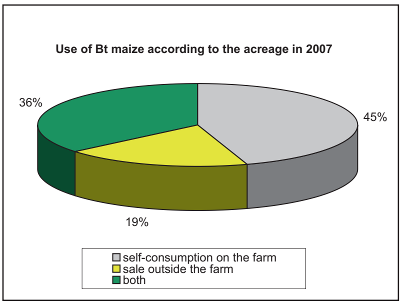




Together with increasing Bt maize areas in the Czech Republic, an increase was also seen in the share of production intended for sale (especially for feed industry), in terms of which it is necessary to label such a production as GMO, in accordance with the valid regulations. This situation is illustrated by Graphs no. 3.3. and 3.4., which capture the increased share in Bt maize sold outside the farm – 27% of growers with the corresponding area of 19%. In 2007, a total of 45% of Bt maize areas farmed by 60% of growers was determined solely for self-consumption on the farm.

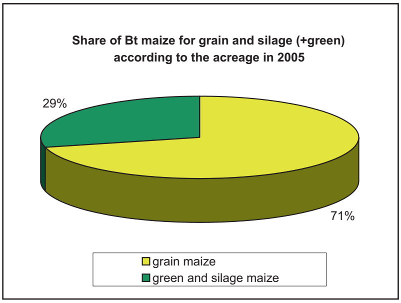
Graphs no. 3.3. and 3.4. – Use of Bt maize in 2007

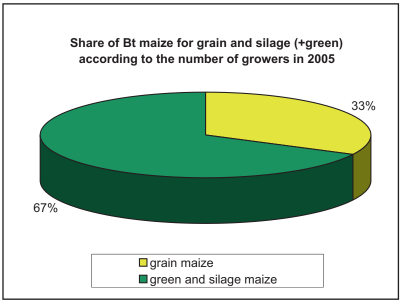




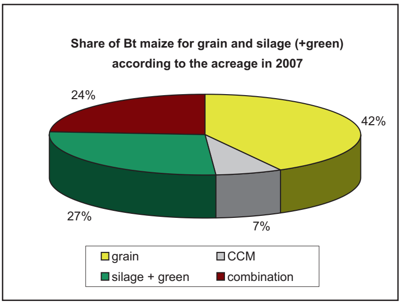
The share of silage (+ green) maize and grain maize in the total Bt maize area can be seen in Graphs no. 3.5. to 3.8.; in 2006 and 2007, growers also distinguished production of wet grain in the questionnaires (CCM – Corn Cob Mix). In 2005, Bt grain maize predominated from the point of view of sown areas (71%), which was cultivated by 33% growers. Most growers (67%) chose silage hybrids of Bt maize in 2005, although these only took up 29% of the total Bt maize area. In 2007, 42% of growers (on 42% of Bt maize areas) grew only Bt grain maize, 34% of growers (on 27% of Bt maize areas) only silage and 13% of growers (on 7% of Bt maize areas) sowed Bt maize for production of CCM. 11% of growers (on 24% of Bt maize areas) cultivated Bt hybrids for both grain and silage.

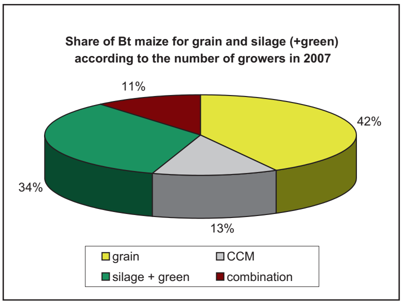
Graphs no. 3.5. and 3.6. – Share of Bt maize for grain and silage (+ green) in 2005





Graphs no. 3.7. and 3.8. – Share of Bt maize for grain, silage (+ green) and CCM in 2007





In the case of selling Bt maize outside the farm, growers are bound by requirements for labelling of such a product as GMO. The obligation to label every product of GM crops and also all conventional products, in which any intentional or accidental or technically unavoidable GMO admixture greater than 0.9% occurs, brings with it the necessity for separate harvesting and subsequent processing. This is then further reflected in more complicated sales of Bt maize products, a matter pointed out by growers in terms of the questionnaire survey. In 2006 and 2007, growers were directly asked whether they had registered any complications in terms of sale of Bt maize product. Table no. 3.4. shows the answers of the growers – respondents.

Table no. 3.4. – Share of Bt maize growers who registered sales problems

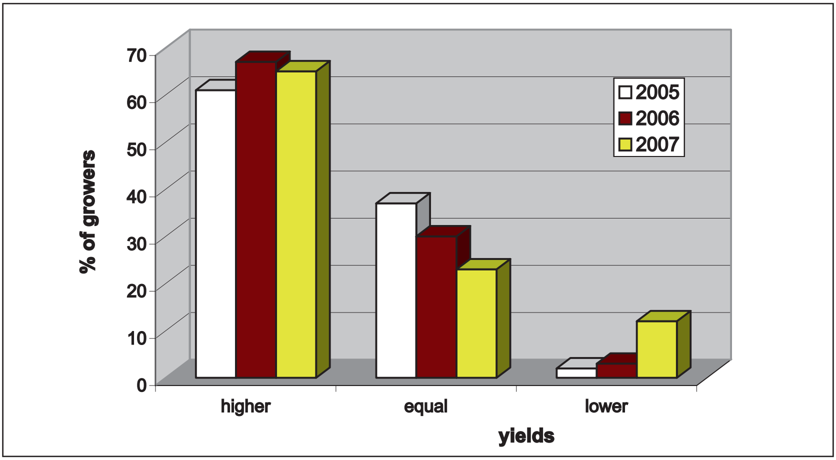
2006 (from a total number of 34 respondents)	9 %
2007 (from a total number of 71 respondents)	11 %
2006 (from 6 growers declaring sales outside the farm)	50 %
2007 (from 28 growers declaring sales outside the farm)	29 %

If we look at the situation from an overall point of view, we then see that in 2006, problems with sales were registered by 9% of growers and in 2007 there was a slight increase to 11%. If however we focus only on the respondents who also stated that Bt maize was intended for sale (not for their own consumption) or a combination of both, we discover that the share of growers who met with problems in terms of sales is quite significant – 50% (3 growers) in 2006 and 29% in 2007. Sale problems are also stated as the main reason for the drop in Bt maize areas in 2009.

3.4. BT MAIZE YIELDS

Until now, in each year of Bt maize cultivation, more than 60% of growers (2005 – 61%, 2006 – 67% and 2007 – 65%) recorded an yield increase compared to conventional maize varieties. On the other hand, few growers saw a decrease in Bt maize yield compared to conventional hybrids (2005 and 2006 – 1 grower), this being the case to an increased extent in 2007 (8 growers). See Graph no. 3.9.

Graph no. 3.9. – Comparison of Bt maize yields with conventional hybrids in 2005–2007



On average, an increase is occurring in Bt maize yield by 7 – 10%. The greatest average yield increase by 9.4% was recorded in 2006, the least by 7.5% in 2007 – however, in this year at least half of growers achieved an average yield increase by 10% (see Table no. 3.5.). The greatest range of values was recorded in 2007 (from +30 to -57%), the lowest in 2006 (from +45 to -7%). The diversity (range) of values can be linked to local cultivation conditions and the (un)suitability of a specific variety for these local conditions.

Table no. 3.5. – Increase in Bt maize yields with comparison to conventional maize hybrids

	2005	2006	2007
average (%)	**8.2**	**9.4**	**7.5**
median (%)	5	7	10
maximum value (%)	61	45	30
minimum value (%)	-15	-7	-57
range of values	76	52	87

The maximum yield increase by 61% was achieved in 2005 in the district of Hodonín, followed by 45% in the district of Břeclav (2006), 35% in the district of Bruntál (2006) and 30% in the districts of Blansko (2006), Znojmo, Bruntál and Litoměřice (all in 2007). On the contrary, decrease in Bt maize yield was reported in the districts of Litoměřice (2007 by 57% and 10%), Znojmo (2007 by 40%, 20% and 14%), Louny (2007 by 20%), Liberec (2005 by 15%), Chrudim (2007 by 12%), Ústí nad Orlicí (2006 by 7%) and Jindřichův Hradec (2007 by 2.3%).

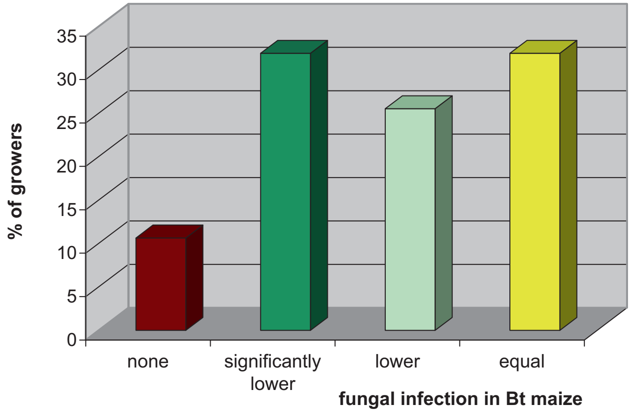
3.5. FUNGAL DISEASES IN BT MAIZE

One of the main advantages when cultivating Bt maize is, according to growers, the significantly improved state of health of Bt maize, which thanks to the toxic protein is not damaged by ECB, secondarily resulting in elimination of access points for fungal pathogens. Growers thus annually, on the basis of visual assessment or measuring of the content of mycotoxins in the product, report a decrease in Bt maize infection caused by fungi.

In 2005, growers did not primarily focus on monitoring of fungal infection in Bt maize, despite this however, 2 growers observed significantly lower infection levels (by more than 50%), 3 growers reported lower infection levels (a difference of up to 50%) and 1 grower did not observe any difference in the infection level in Bt maize. Similarly, in 2006, 5 growers provided information on significantly lower infection levels, 9 on lower infection levels, 5 growers did not register any difference and 1 grower observed a higher infection level in Bt maize crops caused by smuts.

In 2007, growers began to focus more on monitoring of fungal infection in Bt crops. Graph no. 3.10. shows a comparison of fungal infection in Bt maize and conventional hybrids (in most cases this concerns visual assessment and a percentage estimate). Over 40% of growers in 2007 observed a remarkable decrease in infection levels in Bt maize or a completely fungus-free Bt crop, another 25% growers reported a lower infection level in Bt maize. 32% of growers did not observe any difference – in these cases, this concerned either a location with zero or low occurrence of ECB, or locations where ECB in conventional maize was treated with synthetic pesticides.

Graph no. 3.10. – Level of fungal infection in Bt maize in comparison with conventional hybrids in 2007



4. DIRECT EXPERIENCE OF CZECH BT MAIZE GROWERS

This section contains authentic, factually unchanged information about the experience to date of Czech Bt maize growers. Contributions were gained from 4 of the 6 largest current Bt maize growers and also from 4 of the former larger Bt maize growers who decided to end cultivation of this crop for various reasons.

4.1. CURRENT BT MAIZE GROWERS

PLEMENÁŘSKÉ SLUŽBY, a. s.

PLEMENÁŘSKÉ SLUŽBY a. s. Otrokovice has been cultivating Bt maize since 2006, when it sowed 20 ha of the TXP939 A-V variety. In 2007, sowing was increased to 310 ha of DKC 4442 YG and KURATUS BT variety and in 2008, approx. 250 ha were sown with DKC 4442 YG and DKC 3512 YG variety. The company was led to expansion of areas sown with Bt maize due to its favourable experience with its cultivation. After the first year of Bt maize cultivation, decision was made to continue in the following years.

In the opinion of the grower, use of Bt hybrids is more advantageous for the following reasons:

- financial savings on chemical protection against ECB
- as there is no need for application (of pesticides), working time is saved and damage to crops caused by spraying machines is decreased
- harvested grain is healthier – lower level of mycotoxins.

A great disadvantage is adherence to bureaucratic administrative requirements (often absurd and pointless), which complicate regular agricultural life, especially:

- notification of Bt maize areas
- obligation to notify neighbours of Bt maize areas
- obligation to store Bt grain separately and others.

The disadvantage of more expensive seeds is compensated for by the economic benefit of lower costs for protection and better product quality.

In conclusion, the grower expresses his conviction that if the administrative obstacles, which are often absurd, were removed, there would be a massive spread of cultivation of this maize. PLEMENÁŘSKÉ SLUŽBY a. s. Otrokovice intends to cultivate Bt maize also in the future.

ROSTĚNICE, a. s.

ROSTĚNICE, a. s. has been cultivating Bt maize commercially since 2006, when 118 ha was sown, in 2007 – 373 ha and in 2008 – 561 ha, which represents 40% of maize areas and the plan for 2009 stated 500 ha, which represents 50% of maize areas sown on the farm.

ROSTĚNICE, a.s. applies the following technological procedure (comparison of Bt hybrids and conventional hybrids of maize):

type of activity performed/material purchased (quantified in CZK/ha)	**Bt hybrid (DKC 4442YG)**	**non-GM hybrid (DKC 3511)**
breaking the ground	600	600
application of glyphosate (Roundup) – 1 l/ha	500	500
deepening	1,200	1,200
fertilisation with potassium salt – 1q/ha	1,450	1,450
urea 2.5 q/ha	2,325	2,325
preparation of the soil before sowing	700	700
seeds	4,900	3,760
sowing + 1 q/ha Amofos application	3,000	3,000
herbicide application (Trophy 2 l/ha + Click 1.5 l/ha + DAM 100 l/ha))	2,500	2,500
insecticide application against ECB (Integro 0.6 l/ha)	-	1,300
other costs (ground rent, tax, overheads, harvesting, drying)	10 000	10,000
total costs	**27,175**	**27,335**

It is evident from the table comparison that there is no fundamental economic difference in Bt maize cultivation compared to conventional maize, as although Bt maize seeds are more expensive, savings are subsequently made on protection against ECB. The main advantage of Bt maize consists above all in the fact that the crops are absolutely healthy and on the basis of three years of experience, achieve a higher yield by approx. 10%, which provides an economic effect from 1 hectare of approx. CZK 3,000. Apart from this, the company gains a raw material without any mycotoxins whatsoever, which is important in production of feed mixtures. Bt maize can be harvested in the later phases, as there is no risk of the cobs breaking. Apart from the economic effect, the farm is acting in an environmentally friendly manner by eliminating one chemical spray, which also decreases the number of times the land must be crossed and the result of which is a decrease in the demands on equipment and workforce on the farm. Full utilisation of Bt maize is prevented by barriers of some business partners, above all in foreign trade.

Zemědělská akciová společnost KOLOVEČ

Bt maize has been cultivated in Zemědělská akciová společnost Koloveč for the fourth year. Decision was made to cultivate Bt maize due to the high level of ECB infestation in 2005. The infestation level of crops came to 80%. A total of 350 ha of maize is cultivated, of which 80% are Bt hybrids. The farm has had very good experience with them.

Conventional crops infested by ECB were always also subsequently infected by fungi, so the silage was of a very low quality and harmful for livestock. Bt maize plants are healthy, not infested by ECB, i.e. free from fungus. Feed is thus of a high quality. Animals are healthy and provide good quality, healthy milk. Bt maize cultivation is also environmentally friendly due to the fact that the crops do not have to be chemically treated with insecticides. When insecticide is used to control ECB, other insects are also affected, whereas in the case of Bt maize, only the target pest – ECB – is destroyed.

Although Bt maize varieties are more expensive than conventional hybrids, the final result for the business is that Bt maize cultivation is cheaper. There is no longer any need for chemical insecticide treatment, which is costly, and driving through two-metre tall crops leads to crop damage and thus financial loss. Above all, the feed is of a high quality, not infested by fungus and thus harmless for livestock. For this reason, the animals are healthier, last longer and are capable of production for a longer period of time.

The farm will continue to cultivate Bt maize. It is satisfied with Bt varieties. It only regrets that it cannot cultivate 100 % of these varieties due to the need for adherence to 20% refuge. The farm advocates a decrease in the percentage of refuge, for it to be allowed to cultivate Bt maize on the largest area possible.

Zemědělské družstvo MOŘINA

Representatives of Zemědělské družstvo Mořina first met with Bt technologies at the field demonstration days of Monsanto, where they observed trials with Bt maize and were surprised at the zero level of ECB infestation. They decided to try out this technology on their own fields.

In 2005 a trial was performed on the Liteň farm with 5 ha of Bt maize. During harvest, the state of health and yields from these 5 ha then significantly exceeded the yields from other areas. For this reason, they increased the area to 20 ha in 2006, again with superb results. In 2008, they were already cultivating Bt maize on 78% of their maize areas – approx. 500 ha. The quality of maize silage has increased thanks to the superb state of health of the harvested crops and the yield is also approx. 20% higher in comparison with conventional hybrids.

Representatives of Zemědělské družstvo Mořina see the greatest benefit of this technology in the perfect state of health of Bt maize when harvested. If maize is not weakened as a result of ECB infestation, it is also more resistant to adverse weather conditions and infestation by other pests or diseases. Representatives of Zemědělské družstvo Mořina are convinced that only feeding with high quality, healthy feed can lead to a higher efficiency of dairy cattle and a significant reduction in the production cost. After many years of experience, they can recommend this technology to other farms.

4.2. FORMER BT MAIZE GROWERS

AGROSERVIS, 1. zemědělská a. s. Višňové

AGROSERVIS, 1. zemědělská a. s. Višňové decided to cultivate the insect-resistant maize YieldGard type MON810 on the basis of the experience of farmers predominantly from the USA. It cultivated Bt maize in 2006 on an area of 48.75 ha and continued cultivation in 2007 on an area of 98.36 ha.

They found the following advantages in terms of cultivation:

- higher yield of grain maize, given by the fact that the maize is not so stressed by ECB during its growth and development, there is no excessive plants breaking (weakening) before harvesting and thus no higher losses.
- healthier grain; during harvesting, grain is less infested (or not at all) by ECB, and thus there is also less pressure from fusaria, which create toxins.
- lower costs for chemical protection; no costs for insecticide treatment to control ECB.

All of the three points mentioned above showed themselves in practice. It must be added that due to the fact that the plants were healthier, the harvested grain had a higher moisture level (higher costs for drying) in comparison with the same non-Bt hybrids. There were no fundamental problems with cultivation from the agronomic point of view.

Disadvantages of cultivating GMO:

- problems with sale of Bt maize. At a time when there is a gradual attenuation of animal production and the production of feed mixtures relating to this, Bt maize could be ranked as a raw material for production of bioethanol, if this were to fully take off. Sale of GMO outside the country is a problem, e.g. to Austria this is completely out of the question. These problems only lead to a lower sales price – fundamentally lower!
- separate storage. Because Bt maize must be stored separately, higher storage costs are created.
- records and spatial isolation. Records before sowing, after sowing and use of a non-GM maize buffer zone, in order to ensure the spatial isolation (to avoid possible contamination of a neighbouring field with conventional maize) bring with them increased costs.

When evaluating the advantages and disadvantages, it was unequivocally the problematic sale of Bt maize that led the company to cease its cultivation. If there is any demand for Bt maize, the company would be happy to return to it.

BONAGRO, a. s.

BONAGRO, a. s. had already been heading towards the decision to cultivate Bt maize for some time. The clear incentive was to eliminate the damaging impact of ECB, both from the point of view of quantity, but maybe even more from the point of view of quality of the product.

If we disregard cultivation of Bt hybrids on trial fields, then the company acceded to cultivation on a larger area in 2006. The company also continued to use Bt hybrids the next year, both on its production area and also on trial varietal plots.

According to a representative of the company, the specific advantages consist in the absolutely demonstrable increase in product volume, but also in an improvement in the quality and healthy condition of grain as well as silage. This can of course be achieved in other ways whether this concerns chemical or biological protection. Nevertheless, the certainty of the effectiveness of these treatments depends on many factors, which cannot always be precisely assessed and above all influenced, be this pests monitoring and then the atmospheric and climatic conditions at the time of indicated treatment, be this chemical or biological. The effectiveness of the whole treatment then depends on the precise timing. Bt maize practically rules out this risk of imprecise treatment and thus significantly simplifies the whole situation.

The other side of cultivating Bt maize is the more complicated legislation, starting with agreement with all neighbours on the fields, lots of reports to all possible state administration authorities and loss of time with checks by these authorities on Bt maize areas.

Another significant problem is the aversion of certain customers to buying GM raw materials, and the decreased sales of our products relating to this. This especially comes to the forefront at a time when there are overall problems with sales and acts as an initial filter for suppliers in terms of trade.

With a view to improvement of treatment indication to control ECB and new technology which allows for better entry into the crops and treatment of the areas with chemicals, the company has successfully managed to eliminate damage caused by ECB in conventional maize to a significant extent.

After thorough consideration of all aspects both cultivation-related and above all sales-related, BONAGRO, a.s. came to the conclusion that it should limit cultivation of Bt maize, at least for the duration of sales problems with cereals. The company has not however lost its favourable opinion of Bt maize in any way, as the increased price of the Bt seeds is compensated for by the costs saved on chemical treatment.

HORÁKOVA FARMA, a. s.

The agricultural company Horákova farma, a. s. farms on an area of approx. 1,050 ha of agricultural land. Other than 15 ha of vineyards, this concerns arable land. Approx. 700 ha of maize and 350 ha of wheat are cultivated. This intensity of crop rotation corresponds to a danger of ECB spreading. For this reason, the company decided already in 2005 to sow 50 ha with the Bolza GM maize hybrid from Pioneer. The yield of 11.1 tonnes of dry grain per hectare was not really very encouraging, because the Bolza hybrid was one of the last of the previous generation. After great problems with sales, the company ceased cultivation of GM maize in 2006.

In comparison in varietal trials in 2005, the best-performing Bt hybrid PR38A25-YG yielded 14.1 tonnes per hectare of dry grain. The same hybrid in non-GM form yielded 12.4 tonnes per hectare, the difference being 1.67 tonnes of grain per hectare. This was an above-average year.

In 2007, the company sowed maize for a future biogas station, among others also the Bt hybrid DKC 3946-YG on 50 ha, which yielded 20 t/ha of silage with a superb state of health. The company treats conventional grain maize with Steward (insecticide), which has an efficiency of approx. 80% against ECB. Unfortunately this means further chemicals entering the soil.

The company's aim is: 100% silage Bt maize for the biogas station using suitable hybrids, i.e. approx. 300 ha. After removing of restrictions on purchase of GM maize, the consideration is to move over to cultivation of the whole area with GM crops, because the cost for the cheapest application of Steward (insecticide) is roughly the same as the additional charge for the GM seed. With a significant reduction of ECB in the crop, the yield effect between GM hybrids and non-GM hybrids will not be all that high, but there will constantly be a significant difference in the state of health of both forms of maize.

The company believes that education will soon be successful in changing the negative public opinion towards genetic engineering. The general public does not know that 70 – 80% of global soya production is GMO and that the majority of our import is also GMO. With its crop rotation intensity, the company is impatiently awaiting second and third generation of GM hybrids, i.e. those resistant to the Western corn rootworm and tolerant to glyphosate.

They are happy in the company that methanogenic yeasts in biogas stations have no problem with Bt maize, and the company's aim is at least 20 tonnes of healthy maize silage, which corresponds to at least 30,000 kWh per 1 ha.

ROVINA Agro, a. s.

Representatives of ROVINA Agro, a. s. see a great future in Bt maize cultivation. Bt maize was cultivated in the company in 2005 on an area of approx. 14 ha. This was the Bacila variety from Pioneer. Bt maize PR38A25 from the same company was cultivated the next year on an area of approx. 50 ha. Harvested product was used on the farm in its own distillery. When the distillery was closed at the beginning of 2007 as it was making a loss, the company also ceased Bt maize cultivation.

According to a company representative, Bt maize has many advantages compared to conventional hybrids. It produces a higher yield even in years when there is no high ECB infestation; there is no need to treat crops with insecticide.

The company above all sees a great importance for Bt maize in the future: In America, Pioneer is already offering varieties with stacked genes, which are resistant to ECB, Western corn rootworm and tolerant to glyphosate. If these varieties were to reach Europe, this could decrease the cost of maize cultivation (this would depend on the price of the seeds), but above all, the environment would not be so greatly burdened with pesticides. The company representative sees the main contradiction here in the protests of environmental group, who are the main opponents of GM crops cultivation.

This is also linked to the question as to why the company stopped cultivating Bt maize. This was due to the current legislation and aversion on the part of the general public towards these crops. The company representative is of the opinion that the lay public has not been provided with sound information on GM crops.

5. FINDINGS FROM VARIETAL TESTING OF BT MAIZE IN THE CZECH REPUBLIC IN 2004–2008

5.1. REGISTRATION OF VARIETIES IN THE CZECH REPUBLIC

Registration of varieties is a basic condition for acknowledgement and release on the market of reproductive materials of agricultural crops. For growers and other users of varieties, registration not only represents a guarantee of the utility value of the variety and corresponding quality of the reproductive material, but also a guarantee of protection of human, animal and plant health and the environment.

Proceedings on variety registration is regulated by the Act no. 219/2003 Coll., on the marketing of seed and planting material of cultivated plants and on amendment to certain Acts, as last amended. The Central Institute for Supervising and Testing in Agriculture (hereinafter referred to only as "CISTA") decides on registration of varieties via the National Plant Variety Office.

Varieties registered in the Czech Republic are recorded in the National Plant Variety Register. These are regularly published in the List of varieties and also on the following website: www.ukzuz.cz. Common catalogues of varieties of agricultural plant species and varieties of vegetable species are drawn up from the national lists of registered varieties of the EU member countries. The varieties recorded there may be launched on the market in all EU member countries.

Apart from tests for distinctness, uniformity and stability, registration of varieties for important agricultural species incl. maize also includes testing of the utility value. In order to ensure this, CISTA establishes, implements and evaluates long-term varietal testing at locations representing the most important cultivation areas for the crop in question according to the appropriate methodologies.

By law, a variety has utility value if the sum of its characteristics in comparison with other registered varieties represents an evident benefit for cultivation, at least in certain cultivation areas, or for its utilisation and/or products derived from it. If a variety exhibits superb results, it may be excused certain individual worse characteristics. In terms of decision-making on registration of Bt maize hybrids, CISTA does not regard a priori genetic modification of the MON810 type as a main benefit.

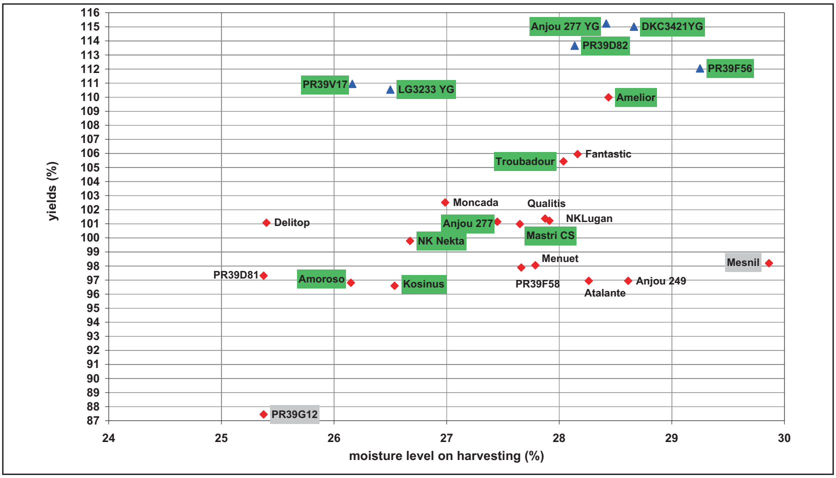
As at the issue date of this publication, 253 maize hybrids were registered in the Czech Republic to 27 holders. From this number, 25 were Bt maize hybrids resistant to ECB. The common catalogue of varieties of agricultural plant species, which also includes varieties registered in the Czech Republic, included more than 4,100 maize hybrids, of which approx. 100 were Bt maize hybrids of the type MON810.

In 2004–2008, CISTA performed varietal tests in terms of registration of various hybrids of GM maize MON810. In terms of these varietal tests, attention was especially paid to differences in yield and fungal infection between Bt maize and conventional hybrids.

5.2. YIELD PARAMETERS OF BT MAIZE

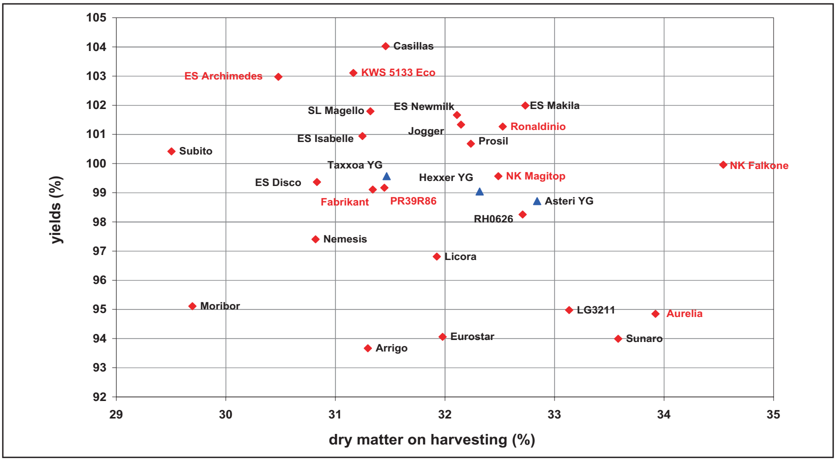
In terms of registration tests with Bt maize, it has been shown that the stalk and cob are not damaged by ECB, break less, assimilate longer, and thus also decrease losses during harvesting. Depending on the level of local infestation by ECB, Bt hybrids can achieve significantly higher yields in comparison with conventional hybrids. An increase was ascertained in registration tests of between 10 and 15% (see example of the early grain maize in Graph no. 5.1. where Bt hybrids are marked with a triangle, newly registered hybrids are highlighted). In isolated cases, in locations with a very high ECB occurrence, there was a yield increase of up to 30%. These results correspond to the high local occurrence of ECB in 2005–2006. In the event of a low or almost zero occurrence of ECB (2007 – 2008), most tested Bt hybrids achieved yields on the level of conventional hybrids. Slightly delayed ripening of the grain was recorded in the case of most Bt hybrids in comparison with the conventional form of the same hybrid, or hybrid in the same category of maturity. It can be concluded that the reason for this is the extended period of assimilation and vegetation of crops not damaged by ECB.

Graph no. 5.1. – Comparison of yield and moisture level of harvested Bt maize hybrids with other hybrids – early grain hybrids (FAO 250–300), 2005–2006



Source: CISTA, Bt hybrids are marked with a triangle

Graph no. 5.2. – Comparison of yield and dry matter of Bt maize hybrids with other hybrids – early silage hybrids, 2007–2008



Source: CISTA, Bt hybrids are marked with a triangle

An interesting finding is that in terms of the process for the registration proceedings in 2007–2008, applications were also made for Bt silage hybrids (for production of green feed or various processed products). Bt silage hybrids equalled other hybrids both in terms of yield (see Graph no. 5.2., where Bt hybrids are marked with a triangle) and also verified quality (digestibility, content of proteins and starches etc.).

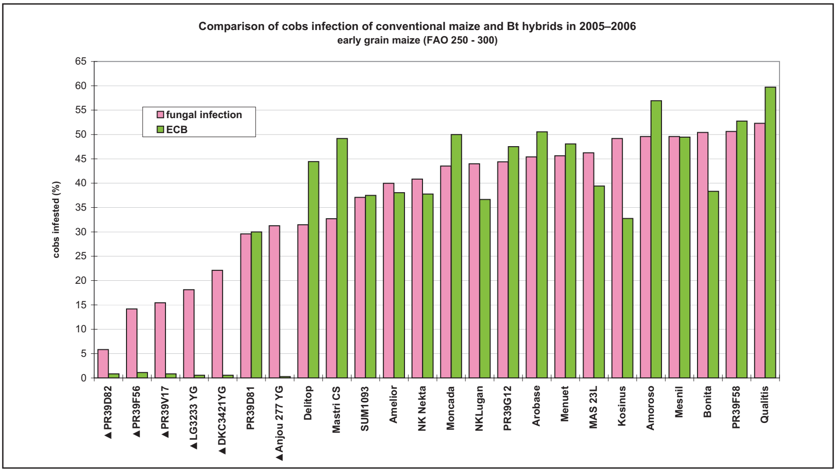
5.3. FUNGAL DISEASES IN BT MAIZE

One of the essential factors for assessment of the suitability of using GM maize is the relationship between ECB damage to the maize cobs and infection caused by fungal pathogens from the genus *Fusarium* sp. This relationship is clearly evident if there is a high ECB occurrence. During visual assessment of varietal tests, a lower level of fungal infection was ascertained in Bt maize in comparison with non-GM hybrids (see examples of the early grain maize in Graphs no. 5.3. and 5.4.).

In the registration test, the percentage of cobs infected with fusaria was lower for most Bt hybrids, even in years with a remarkably decreased ECB population. E.g. in the period 2007–2008 it was ascertained that infection with fusaria in the cobs of Bt hybrids (7 – 10%) achieved a level of less than 50% of the average infection in non-GM hybrids (15 – 17%). On the basis of statistical evaluation, it was ascertained that Bt hybrids are in general statistically significantly less prone to infection by fungal diseases than non-GM varieties, even with a relatively low level of ECB infestation.

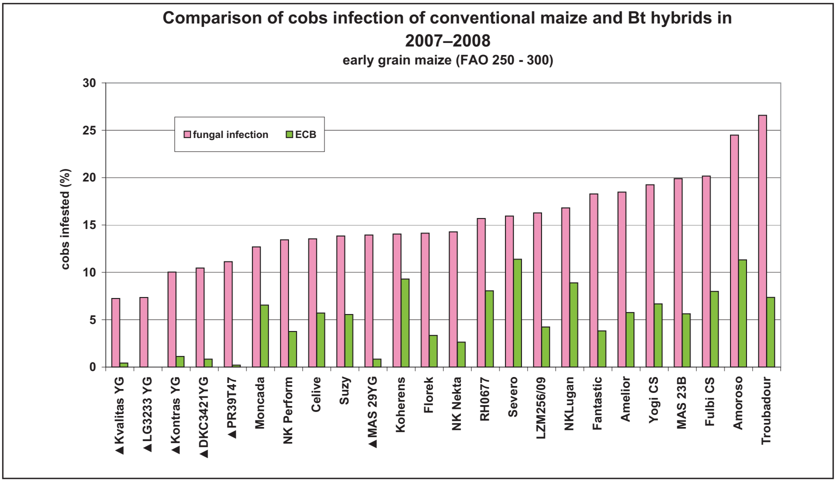
Fusaria can produce mycotoxins, which pose a health threat to people and animals. In connection with this, CISTA carried out determination of the mycotoxin deoxynivalenol (DON) content in a selected collection of samples from the harvests of varietal tests in 2006 and 2007. On the basis of the results of this limited collection of samples, no dependence has as of yet been proven between the level of infection of cobs by fusaria (visual assessment on the field) and the content of the mycotoxin deoxynivalenol ascertained in the grain. The importance of this matter will however require further more detailed assessment in the future.

Graph no. 5.3.



Source: CISTA, Bt hybrids are marked with a triangle

Graph no. 5.4.



Source: CISTA, Bt hybrids are marked with a triangle

5.4. SUMMARY

The level of ECB infestation in the years 2004–2008 allows for comparison of Bt maize and conventional hybrids under various conditions. In years with a low level of ECB infestation, the yield increase of Bt hybrids compared to conventional hybrids is low or almost zero. In years with a higher level of ECB infestation, it is possible to achieve a 15% to 25% increase in yield with Bt hybrids. The percentage of fungal diseases provoked by ECB in cobs also speaks expressively in favour of GM hybrids. The fundamental advantage is that the yield and qualitative level of registered Bt hybrids remains constant year-on-year without use of chemical pesticides or biological means of crop protection.

This is why implementation of protection against ECB with the aid of Bt maize remains a strategically important method when gaining product, which is burdened as little as possible with mycotoxins, without it being necessary to accede to fungicidal protection. It can also be stated that Bt maize hybrids could be one of the important elements reducing the use of synthetic pesticides.

6. MONITORING OF BIOLOGICAL EFFECTIVENESS OF BT MAIZE IN THE CZECH REPUBLIC IN 2006–2008

Monitoring of biological effectiveness of Bt maize in the Czech Republic is dealt with by the State Phytosanitary Administration (hereinafter referred to only as "SPA"). The legal obligations and competences of the SPA when checking Bt maize result from the Act no. 326/2004 Coll., on medical plant care and amendment to certain related Acts, as last amended.

6.1. AIM AND METHODOLOGY

The main aim of monitoring the biological effectiveness of Bt maize is to monitor the development of ECB population resistant to the toxic protein produced by Bt maize. Discovery of a resistant population, which can in general also occur with the conventional method of farming, would in this case mean a loss of the competitive advantage, which Bt maize currently offers growers. The expert opinions on the time over which resistance could theoretically occur, differ greatly. Nevertheless, in countries where Bt maize has been cultivated for a longer time, or in more southerly located areas where ECB has several generations per year, the risk of occurrence of a resistant population is greater than in the Czech Republic.

Apart from SPA, measures to control the occurrence of resistance are also being dealt with by companies providing Bt maize seeds and the growers themselves. The most frequent prevention against the occurrence of resistance is crop rotation and creation of so-called refuges. Refuges are the areas close to or directly in the crops of Bt maize, which are sown with classic non-transgenic maize. Isolation strips (buffer strips) are frequently used as refuge in practice, which also serves as a barrier against dissemination of Bt maize pollen to fields with non-GM maize.

Monitoring of biological effectiveness is performed by workers from regional SPA divisions in line with appropriate methodology. 30 Bt maize plants are checked on each monitored plot. During the check, plants are chosen that seem to have been infested (weak or broken plants). The stalk and the cob of the chosen plants is first cut open lengthwise, and then the pulp is inspected to see whether it contains any ECB larvae. If any larvae is found in the plant, this is placed in a test tube with 70% alcohol. Samples of leaves are collected from the infected plants and everything is sent to the diagnostics division for confirmation of the correct determination of the larvae (whether this really does concern a larvae of ECB) and for laboratory verification as to whether the infected plant really is Bt maize. Samples of the maize plants are tested using the PCR (Polymerase Chain Reaction) method for the presence of the Bt transgene and also using the ELISA (Enzyme-Linked Immunosorbent Assay) method directly for the presence of the toxin itself.

6.2. RESULTS

Monitoring of biological effectiveness has been performed in the Czech Republic since 2006, whereas the number of checks is increasing in relation to the increasing Bt maize area. In 2007, a check in the refuge or neighbouring maize adjacent to Bt maize was also performed. The numbers of checks and their results for individual years are set out in Tables no. 6.1., 6.2. and 6.3.

Table no. 6.1. – Frequency and results of monitoring biological effectiveness of Bt maize in 2006

SPA regional division	number of checks in Bt maize	number of positive findings in Bt maize
Brno	22	6
Havlíčkův Brod	5	1
Louny	0	0
Opava	2	1
Plzeň	2	0
Praha	6	1
Tábor	2	1
Total	**39**	**10**

Table no. 6.2. – Frequency and results of monitoring biological effectiveness of Bt maize in 2007

SPA regional division	number of checks in Bt maize	number of positive findings in Bt maize	number of checks in refuge (non-GM maize)	number of positive findings in refuge (non-GM maize)
Brno	10	2	5	4
Havlíčkův Brod	28	0	21	18
Louny	1	0	1	1
Opava	5	1	5	2
Plzeň	12	0	12	10
Praha	14	0	9	8
Tábor	5	0	4	2
Total	**75**	**3**	**57**	**45**

Table no. 6.3. – Frequency and results of monitoring biological effectiveness of Bt maize in 2008

SPA regional division	number of checks in Bt maize	number of positive findings in Bt maize
Brno	11	0
Havlíčkův Brod	13	1
Louny	1	0
Opava	9	0
Plzeň	8	0
Praha	15	1
Tábor	27	0
Total	**84**	**2**

In 2006 in terms of 39 checks, infected plants were found in 10 crops. However, in this year additional laboratory analyses were not yet performed on the leaves of infected maize plants, as it was assumed that areas registered as Bt maize crops would not contain any admixtures of conventional maize. This assumption proved to be erroneous and after implementation of laboratory tests, the numbers of positive findings dropper to 3 in 2007 and 2 in 2008. In addition to this, most of these findings were made in crops with a great amount of weeds, where the danger of larvae crawling over from another host plant is much higher than in an area not infested with weeds.

In all cases when checks in Bt maize crops showed positive results, this concerned finding of one single larvae in the whole crop and the larvae was taken from the surface of the maize plant, or the feeding tunnel was very short. The pest was thus discovered immediately after giving crawled onto the Bt maize from another host plant, probably some field weed, before the Bt toxin was able to start working.

In conclusion, it can thus be summarised that on the basis of observations so far, cultivation of Bt maize has to date proved a reliable way of protection against ECB.

7. ECONOMICS OF BT MAIZE CULTIVATION IN THE CZECH REPUBLIC

The economics of Bt maize cultivation have been dealt with by the study "Cost-benefit analysis of genetically modified (GM) maize cultivation, its comparison with cultivation of non-GM maize", which was elaborated by the Institute of Agriculture Economics and Information in 2008. The aim of the analysis was to gather data from growers, to perform economic comparison of cultivation of GM and conventional hybrids and especially to compare the average (direct and indirect) costs, yields, sales prices and benefits in the cultivation season 2007.

7.1. METHODOLOGY

Cost-benefit analysis concerns enumeration of all direct and indirect costs and benefits for the purpose of assessment of incomes created in comparison with financial investment.

The method used for collection and processing of data was a Sample survey on costs and benefits of agricultural products, ensured annually in selected companies through the Farm Accountancy Data Network Czech Republic, which has available qualitative data about costs and benefits for individual crops. The sample survey in 2007 included 59 agricultural subjects with cultivation of conventional grain maize and their share in the total grain maize area in the Czech Republic was 10.2% (Poláčková a kol., 2008). Information about Bt maize was gained with the aid of modified questionnaires for the sample survey, supplemented to include technological information (above all about sowing, fertilising and plant protection) and face-to-face communication with three growers with a larger Bt maize area.

Use was made of the following calculation formula for complete own costs for the cost-benefit analysis (Novák, 1996):

Items in the calculation formula

1. Material purchased	(seeds, fertilisers, plant protection products and other direct material)
2. Own production input	(seeds, fertilisers and other own products)
3. Insurance premium	(agricultural insurance for crops)
4. Labour costs	(wage and other personnel workers' costs incl. contributions towards health insurance and social security)

5. Costs for auxiliary activities	(costs for own machinery, e.g. fuel, repairs and maintenance, road tax)
6. Production overheads	(e.g. wages and other agronomist's costs, depreciation of FITA, rent, spare parts and material for repairs and other items common for plant production)
7. Administration overheads	(e.g. wages and other director's personal costs, electricity, communication costs, depreciations of FITA for the administrative building, rent, interest and other items common for the whole business)

The total costs for grain maize, where two products are simultaneously produced by one production process (grain and straw), are broken down into individual products according to the set ratio coefficients (85:15).

The average sales price used for assessment of the profitability of grain maize was calculated from the total income for grain maize sold, divided by the amount of grain sold, taken from the sample survey on costs and benefits of agricultural products for 2007. The average sales price used at the level of 4,960 CZK/t of grain corresponds to the development of prices of agricultural producers, stated by the Czech Statistical Office (average in 2007 was 4,183 CZK/t).

The benefit side of the analysis uses the cost profitability indicator calculated according to the formula:

$$\text{profitability level} = \frac{\text{average sales price} - \text{own product costs}}{\text{own product costs}} * 100$$

7.2. RESULTS

Comparison of total costs and individual cost items for conventional maize and Bt maize in 2007 is shown in Table no. 7.1. It is evident from the comparison that Bt maize had total costs for 1 ha of harvested area at roughly CZK 700.00 lower than classic hybrids. Moreover, significantly higher hectare yields were achieved with Bt maize. This also showed itself in the marked difference in own production costs for 1 t of grain, when Bt maize had lower own costs by more than CZK 750.00/t of grain.

From the individual cost items in 2007, the most significant share of total costs for conventional maize was taken by overheads with a share of 29.5% and costs for auxiliary activities (i.e. costs for operation of own machinery) with a share of 20.1%. Similar shares in total costs can also be seen in the case of Bt maize, when overheads reached a level of 28.7% and costs for auxiliary activities 21.7%. Another significant item was total direct material costs, which came to more than 34% for both conventional maize and Bt maize. It is evident from this that when looking for further sources of effective savings when cultivating grain maize, it would be appropriate to focus on items with a large share in the total costs.

The structure of costs was similar in both assessed types of maize. Greater differences only came to light in the structure of direct material costs, where the costs were more in the case of Bt maize for seeds purchased (by 28.5% compared to conventional hybrids), but on the other hand, costs for plant protection products were remarkably lower (by as much as 42% compared with conventional hybrids). Lower costs for plant protection in Bt maize, which were achieved thanks to saving on application of insecticides to control ECB, also subsequently showed themselves in a slight decrease in wage costs and costs for auxiliary activities compared with conventional hybrids. Because the technology for cultivation of conventional hybrids and Bt maize (other than the above-mentioned differences) is basically the same, savings on one operation did not result in any marked

Table no. 7.1. – Costs and profitability of conventional maize and Bt maize cultivated for grain

indicator	unit of measurement	conventional maize hybrids	Bt maize
seeds – purchased	CZK/ha	3,422	4,431
seeds – own	CZK/ha	28	0
fertilisers – purchased	CZK/ha	1,734	1,734
fertilisers – own	CZK/ha	168	168
plant protection agents	CZK/ha	3,293	1,901
total direct material costs	CZK/ha	8,645	8,234
insurance premium	CZK/ha	1,047	1,368
wages and personnel costs	CZK/ha	2,594	2,528
costs for auxiliary activities	CZK/ha	5,368	4,825
production overheads	CZK/ha	4,746	4,746
administration overheads	CZK/ha	2,360	2,360
total costs	CZK/ha	24,760	24,061
share in main production	%	85	85
own production costs	CZK/ha	21,046	20,452
hectare yield	t/ha	6.94	9.00
own production costs	CZK/ha	3,033	2,272
average sales price	CZK/ha	4,960	4,960
level of profitability	%	63.6	118.3

Source: Sample survey on costs and benefits of agricultural products for 2007
Drawn up by: B. Janotová, J. Poláčková (Institute of Agricultural Economics and Information)

decrease in wage costs and costs for auxiliary activities. Bt maize cultivation of is above all more effective thanks to the savings on direct material cost and in the higher yields.

Cultivation of both types of grain maize was profitable in 2007. The very favourable level of profitability in the case of Bt maize was above all influenced by the lower production costs and markedly higher yields. The difference between the production costs and yields in the case of Bt maize and conventional maize above all showed itself in the great difference in the level of profitability. The level of profitability in the case of Bt maize was 118.3%. On the contrary, conventional hybrids achieved a level of profitability of 63.5%.

7.3. SUMMARY

It is evident from the analysis that costs for production of 1 t of Bt maize are significantly lower. This is influenced not only by the lower total costs for 1 ha of harvested area, but above all by the higher hectare yields. Bt maize achieves up to 20% higher yields in comparison with conventional maize hybrids. Slightly lower total costs for 1 ha were above all achieved thanks to savings on insecticides despite the higher costs for seeds. Bt maize is thus of benefit for agricultural businesses.

Agricultural companies, which have decided to cultivate Bt maize are mostly satisfied with their results and intend to continue to cultivate this crop. This above all concerns those companies, which involve animal production and can use Bt maize to feed the animals on the farm. Other agricultural companies are ceasing cultivation of Bt maize due to the fact that it entails demanding paperwork and the great problems that arose when trying to sell this product.

The unfavourable situation on the market with Bt maize is not only influenced by the low level of information provided about GM crops and the negative stance towards them, but also by the demanding administration relating to storage and subsequent sale of GMOs. Farmers who intend to continue Bt maize cultivation also complain about the excessive documentation on handling Bt maize, however they hope that the administrative demands and negative attitude of the public towards GM crops will decrease in the future.

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8. CONCLUSION

Agricultural adoption of GM crops began in the second half of the 1990s. Over the course of 14 years, the original production area (1.7 mil. ha in 1996) has grown more than 70x to the current level of 134 mil. ha (2009). GM crops have not so far taken such a great hold in the EU, especially with a view to the negative attitude of European consumers towards GMO and also the specific approval procedure and binding legal regulations, based on precautionary principle.

Only Bt maize MON810 had been permitted for commercial cultivation in the Czech Republic (resp. EU) by the end of 2009. It represents a significant alternative in terms of maize protection against ECB, the economic harmfulness of which has already become evident in many regions of the Czech Republic. Bt maize creates its own insecticide, so it is not necessary to use additional chemical or biological protection methods against the pest. Bt maize cultivation (and in general, any GM crop) is accompanied in the Czech Republic by specific rules, the purpose of which is separation and subsequent labelling of Bt maize product as GMO and the aim of which is to preserve the possibility of choice between various production systems (conventional, organic and based on GM crops).

In the Czech Republic, Bt maize has been commercially cultivated since 2005, i.e. this so far concerns limited experience, both from the point of view of time and also from the point of view of its minority share in the total agricultural production. In 2008, with what was so far the largest area of 8,380 ha, Bt maize covered less than 3% of the total maize area in the Czech Republic. Between 2005 and 2008, not only the total Bt maize area gradually increased, but also the size of individual plots. In 2008, the Czech Republic already registered 2 farms with a total Bt maize area greater than 500 ha and the largest plot had an area of 123 ha. In general, the historically given above-average size of farms and also fields in the Czech Republic (in comparison with other EU member countries) is a good basis for the success of the coexistence concept, i.e. preserving various types of production.

The first drop in Bt maize areas occurred in 2009, when the main reason for this was problematic sale of this type of maize, which must be separated from conventional maize product and labelled as GMO. The decrease in Bt maize areas may also relate to the overall decrease in maize areas in the Czech Republic in 2009. In terms of this development it can, among other things, be stated that there is no need to accede to restrictive measures or even bans on cultivation by the state authorities as concerns GM crops, which have been approved and assessed by scientific entities as safe for the EU market, as the market is capable of regulating use of the biotechnological products itself on the basis of consumers' demand.

Until now, technology based on Bt maize has been used by 255 growers (+ 4 research subjects), of which 14 entities already have 5 years of experience in growing this crop. Bt maize is most abundantly represented in South Moravia and the Region of Central Bohemia, where there is also a significant ECB occurrence. On the contrary, Bt maize is cultivated very rarely in the Liberec and Karlovy Vary Region. With regards to legal form of growers, Bt maize is sown most by partnerships, although natural persons and cooperatives do also have significant experience.

The initial experience of Czech growers with Bt maize, which were documented on the basis of the questionnaire survey by the Ministry of Agriculture of the Czech Republic, can be evaluated as predominantly positive. It can in general be said that grower's experience is influenced by local conditions of a natural but also socio-economic nature. Bt maize growers especially see advantages in the technology itself – ranging from the simplicity and reliability of protection against ECB and decrease in the need of production inputs, right through to the resulting effect during harvesting (crops that are not broken or lodged). On the basis of the questionnaire survey, it can also be stated that when cultivating Bt maize, Czech farmers on average achieve higher yields than when cultivating conventional hybrids and the harvested product is of a higher quality with a view to the lower fungal infection. At the same time, an important role is played by the level of local ECB occurrence and alternative approaches in protection of conventional maize (chemical/biological methods or without any treatment at all). Another of the basic findings is that Bt maize represents not only an economic benefit for the grower, but also brings with it positive aspects for the environment (an alternative to use of synthetic insecticides to control ECB and decrease in the need to use machinery). As far as the frequently discussed negative effects on the environment are concerned (e.g. impact on non-target, useful organisms, or other negative changes in the local flora and fauna), these were not observed by Czech growers.

On the other hand, Bt maize cultivation does also bring with it certain disadvantages, in terms of which there is a marked predominance of dissatisfaction with the legislative-administrative background, which inherently belongs to cultivation and generally to any use of GM organisms in the EU. From an economic point of view, growers identify additional costs at production input (more expensive seeds for Bt hybrids) as well as problems at production output. These result from fear and doubts which still persist among consumers with regards to GMO and their products and even products from animals, which were fed with Bt maize. These problems relate in general to the negative perception of GMOs in the EU.

Direct statements from the largest Czech Bt maize growers and also those who have stopped cultivating this crop, are in accordance with the findings gained in the questionnaire survey. In terms of this, great emphasis is placed on the superb state of health of Bt maize crops and subsequently also the harvested product as well as the environmentally friendly character of the technology. On the other hand, growers see administrative and especially sales obstacles in the path of wider GM crops utilisation. All growers contacted praised Bt maize as beneficial and express their hope for greater use of technology based on GM crops (not only Bt maize) in the future.

The benefits of Bt maize are also confirmed by the results gained in varietal testing, which is performed in the Czech Republic by Central Institute for Supervising and Testing in Agriculture. Certain regional and year-to-year differences can also be seen in terms of these results. No fungicide effective in controlling fungal diseases of the cob is registered for use in maize in the Czech Republic. Here, Bt hybrids could represent a possible solution, as in terms of visual assessment of trials, a lower level of infection by fungal diseases was ascertained in comparison with conventional hybrids.

Positive results for Bt maize cultivation are also provided by economic analysis performed by Institute of Agriculture Economics and Information, which among other things, attributes a greater profitability of production to Bt hybrids in comparison with conventional approaches. Another positive finding is the fact that in terms of monitoring of the biological effectiveness of Bt maize, which is performed by the State Phytosanitary Administration, no occurrence of ECB resistance has been found in the Czech Republic. Bt maize cultivation thus so far seems to be a reliable method of protection against this pest.

From the above-mentioned findings, it is among other things evident that the results of Bt maize in comparison with conventional hybrids cultivation cannot be generalised for the whole Czech Republic, or even in terms of one region. It is thus desirable to leave the decision on use of new technology directly in the hands of growers, this in the case of GM crops, which have been declared to be as safe as their conventional forms on the EU level. In this respect, growers (and subsequently also consumers when buying the final product) are the most competent persons to verify and assess the success of the new technology to local conditions in comparison with conventional technologies. The Ministry of Agriculture of the Czech Republic highly prizes open communication from and among growers and sharing of experience with Bt maize cultivation, as this information represents a significant contribution for objective assessment of new technology, which is still perceived as controversial in the EU.

On the basis of the above-mentioned findings and with a view to the existing situation in the field of GMOs in the EU, it can be expected that the interest of Czech growers in technologies based on GM crops will grow proportionately to the level of tolerance of GMO on the part of European consumers, and the development of legislation in the EU relating to this. These aspects currently to a certain extent limit the problem-free choice of growers and consumers between the agricultural systems and products available, from which the conventional method of farming so far remains the dominant system of production, not only in the Czech Republic.

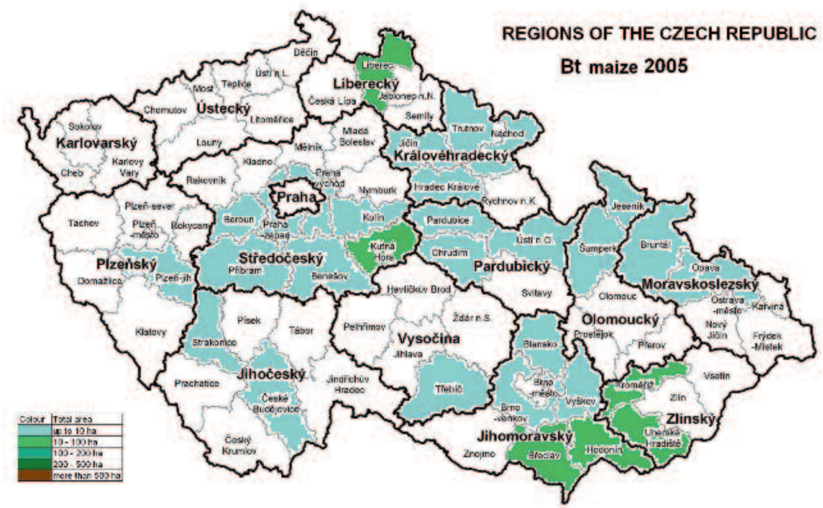
9. APPENDIX

Occurrence of the European corn borer (ECB) and its coverage with Bt maize areas in the Czech Republic

First ECB occurrence within the territory of the Czech Republic dates back to the 1950s. Except for sporadic occurrences, ECB only caused large-scale damage in South Moravia, above all in the 70s and 80s. In general however, more significant damage did not begin to be caused by ECB until the 90s, when its harmful occurrence was recorded in 27 regions in the Czech Republic (predominantly in South Moravia, Central Bohemia, the Ústí nad Labem, Liberec and Zlín Region). This damage was above all caused by the more favourable temperature conditions for the life and survival of the pest. Indirect contribution to this was also the existing trend of increasing areas of grain maize, partially to the detriment of silage maize. In relation to this trend and in combination with the favourable temperature conditions, it can be anticipated that the damage levels caused by ECB will most likely continue to grow.

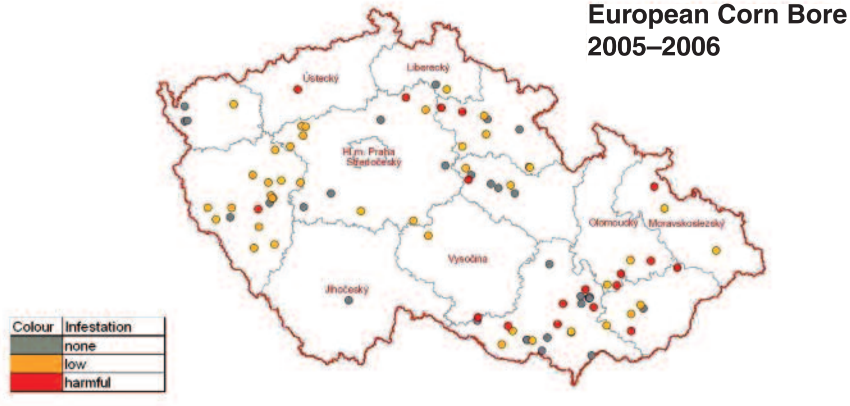
If we look at the maps showing occurrence of and damage caused by ECB and at maps of the Bt maize areas for the period 2005–2008 (see Figure no. 9.1. – 9.7.), we can see that except for minor deviations, the growth in Bt maize areas in individual years altogether copies the locations with a low or harmful occurrence of the pest the previous year. Despite the fact that Bt maize is resistant to ECB, it cannot unambiguously be said, how significantly it can influence the population density of the pest in the region in question. Consideration must also be made of other methods used for protection against this pest. From a geographical point of view, it will be necessary to continue to monitor the occurrence of and damage caused by ECB in relation to the increase in Bt maize areas in individual regions.

Figure no. 9.1.: Intensity of Bt maize cultivation in the Czech Republic in 2005



Source: Josef Kubíček, Ministry of the Environment of the Czech Republic

Figure no. 9.2.: ECB Occurrence and its harmfulness in the Czech Republic in 2005–2006

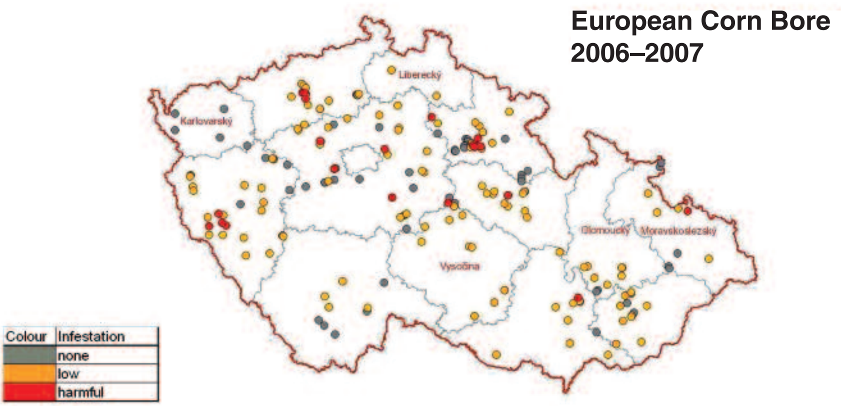


Source: State Phytosanitary Administration

Figure no. 9.3.: Intensity of Bt maize cultivation in the Czech Republic in 2006

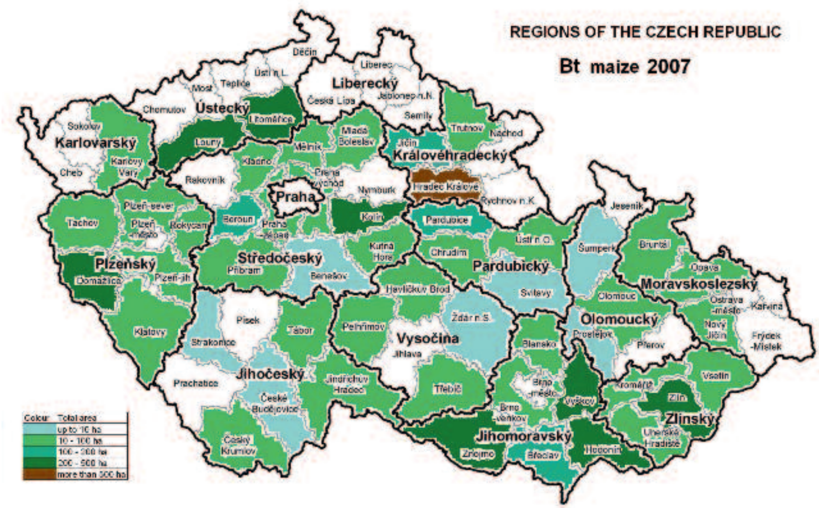
Source: Josef Kubíček, Ministry of the Environment of the Czech Republic

Figure no. 9.4.: ECB Occurrence and its harmfulness in the Czech Republic in 2006–2007



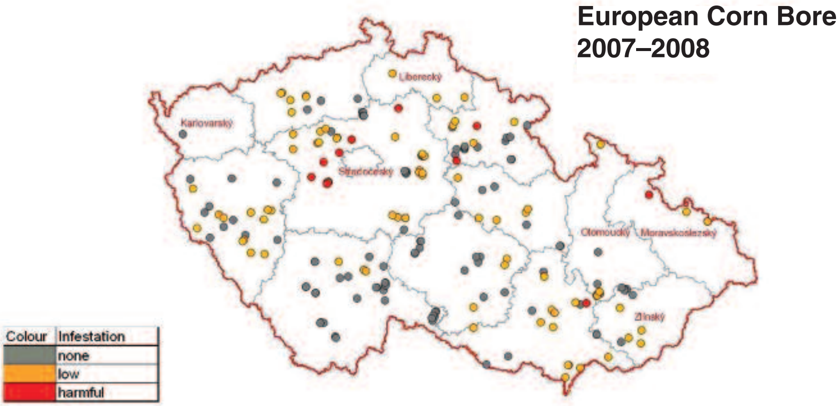
Source: State Phytosanitary Administration

Figure no. 9.5.: Intensity of Bt maize cultivation in the Czech Republic in 2007



Source: Josef Kubíček, Ministry of the Environment of the Czech Republic

Figure no. 9.6.: ECB Occurrence and its harmfulness in the Czech Republic in 2007–2008



Source: State Phytosanitary Administration

Figure no. 9.7.: Intensity of Bt maize cultivation in the Czech Republic in 2008

Source: Josef Kubíček, Ministry of the Environment of the Czech Republic

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