Literature survey of Bt maize cultivation 2006-2007
(economic analysis and environmental impact analysis)

I. Economic Benefits of Bt maize cultivation

Andersen, M.N., Sausse, C., Lacroix, B., Caul, S., Messean, A., (2007) Agricultural studies of GM maize and the field experimental infrastructure of ECOGEN. Pedobiologia, in press.

Within the ECOGEN project, long-term field experiments with MON 810 maize were conducted to study agro-ecological effects on the soil fauna and agro-economic implications of the technology. Bt-maize produced a higher grain yield and grain size than a near-isogenic non-Bt variety or allowed a significant reduction in pesticide use. Concentrations of Cry1Ab in the Bt-varieties were sufficient to effectively control corn-borer larvae.

Brookes, G. (2007) The benefits of adopting genetically modified, insect resistant (Bt) maize in the European Union (EU): first results from 1998-2006 plantings. PG Economics Ltd. **www.pgeconomics.co.uk**

In maize growing regions affected by ECB and MSB, the primary impact of the adoption of Bt maize has been higher yields compared to conventional non genetically modified (GM) maize. Average yield benefits have often been +10% and sometimes higher; In 2006, users of Bt maize have, on average, earned additional income levels of between €65 and €141/ha. This is equal to an improvement in profitability of +12 to +21%; In certain regions, Bt maize has delivered important improvements in grain quality through significant reductions in the levels of mycotoxins found in the grain.

Wesseler, J., Scatasta, S., Nillesen, E. (2007) The Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) and other benefits and costs of introducing transgenic maize in the EU-15. Pedobiologia, in press.

The EU-15 forgo several million Euros of net social benefits per year by postponing the introduction of Bt-maize, although this can be justified, if decision makers assume that the willingness-to-pay by household for not having those crops being introduced is about one Euro on average per year.

II. Environmental Risk-Benefit Analysis of Bt maize cultivation

There is extensive and recent scientific literature available about the environmental impact of Bt maize cultivation in different areas:

(1) Release of grain maize that is able to germinate into the environment (losses during harvesting, transportation and processing)

Chapman & Burke (2006): The authors published a review that deals also with the establishment & spread of GM plants. In recent years, it has become increasingly clear that hybridization between crop plants and their wild relatives is the rule, as opposed to being an exception. Moreover, population genetic theory has shown us that the likelihood of establishment and rate of spread of an allele are governed primarily by the strength of selection, as opposed to the migration rate. Thus, even if crop × wild hybridization is a rare occurrence, a moderately advantageous transgene would be expected to spread quickly following its escape. Although increased individual fitness does not necessarily translate into increased invasiveness, fitness remains the best predictor of allelic spread. Thus, the fitness effects of a gene in the wild are a far more important consideration than the overall rate of gene flow.
Conclusion: There is no direct evidence for escapes of Bt maize kernels able to germinate into the environment.

(2) Release of the Bt-toxin into the environment (for example via pollen, silage, plant residues in the soil)

Andersen et al. (2007): Within the ECOGEN project, long-term field experiments with MON 810 maize were conducted to study agro-ecological effects on the soil fauna and agro-economic implications of the technology. In soil, Cry1Ab was close to the limit of detection and the protein did not accumulate in the soil year on year. These reports are in line with previous data assessed by EFSA (2006).

McHughen (2006): Pollen flow studies are necessary, but by themselves are insufficient. The point of Biosafety investigations is to inform the scientific community, regulators and society at large of the relative hazards posed by GM crops. But the pollen flow studies, although necessary, are insufficient because (1) measures of pollen flow don't identify actual hazards (if any) posed as a consequence of the inevitable gene escape and (2) without some comparative data we don't whether pollen-based gene flow is a greater or lesser means of gene escape than other common routes (such as seed spillage or volunteerism). Unless and until we compare pollen-based gene flow with other means of gene escape, we cannot properly inform policymakers, and thus we are incomplete in our scientific assessments.
Conclusion: There is no evidence for large Bt-toxin accumulation into the environment.

(3) Bt-toxin remaining in the soil of the cultivation areas; impacts on soil organisms and soil functions, Widmer 2007: Deleterious effects of transgenic plants on soils represent an often expressed concern, which has catalyzed numerous studies in the recent past. In this literature review, studies addressing this question have been compiled. A total of 60 studies has been found, and their findings as well as their analytical approaches are summarized. These studies analyzed the effects of seven different types of genetically engineered traits, i.e., herbicide tolerance, insect resistance, virus resistance, proteinase inhibitors, antimicrobial activity, environmental application, and biomolecule production. For Bt maize, a number of 12 studies was analysed (4 with MON810). The result of the overall 60 studies presented by Widmer (2007) indicate that the tools for sensitive detection of changes in soil microbiological characteristics are available; however, they also reveal that at present it is very difficult or impossible to define which alterations in these characteristics may represent unacceptable damage to a soil system. This limitation becomes evident from the scientific literature presented here, as no study reported damage of a soil system, but rather potentially adverse effects.

Vercesi et al. (2006): This study indicates that CRY1Ab-expressing maize apparently poses minimal risks to earthworms as far as growth and reproduction is concerned. Vercesi et al. (2006) also recognized a small negative effect on cocoon hatching success, but this was at relatively high concentrations of finely ground CRY1Ab-expressing maize material and it can be questioned whether this effect would have any ecological significance under field conditions.

Krogh & Griffiths (2007**):** ECOGEN was a research initiative funded under the European Commission Framework 5 programme, designed to integrate the combined soil ecological and economic effects of introducing systems including genetically modified (GM) crops by performing data mining and building decision support systems. The project involved eight academic partners from five EU countries and an input from Monsanto. Maize expressing an insecticidal protein from Bacillus thuringiensis (Bt-maize) was chosen as the model GM crop due to its availability, while studies using GM herbicide tolerant (HT) maize were initiated in the latter stages of the project. Single species tests under laboratory conditions (not presented in this issue) showed conclusively that Bt-toxin has no deleterious effects on protozoa, nematodes, earthworms and collembolans. The agrochemicals characteristics of the cropping systems studied were similarly non-toxic at field concentrations. More detailed measurements in mesocosms revealed that the slight effects of Bt maize or a conventional insecticide on nematodes, protozoa and microorganisms were less pronounced than effects due to soil and plant growth stage (Griffiths et al., 2006), and less than the variation seen between eight maize cultivars (Griffiths et al., 2007). No effects could be attributed to the Bt maize on snails, microarthropods or mycorrhizal fungi in a separate mesocosm experiment, but the detection of Bt protein in snail faeces was identified as a novel route into the soil food web (de Vaufleury, 2007). Field experiments were established at four sites across three European climatic zones and showed the effectiveness of Bt maize against the European Corn Borer, where this pest was present (Andersen et al., 2007). These field experiments point to the conclusion that Bt-maize (Mon 810 event) could have a significant, but small and transient, negative effect on soil protozoa, nematodes and microorganisms (Griffiths et al., 2005; 2007) but no effects on organic matter (wheat straw) decomposition (Cortet et al., 2006). Generally Bt-maize did not affect earthworms (Krogh et al., 2007) and microarthropods (Cortet et al., 2007), while a data mining approach revealed the interplay between factors affecting earthworms and microarthropods (Debeljak et al., 2007). The fact that we conducted experiments using the same organisms and soils across a range of scales (i.e.

laboratory, glasshouse and field) allowed for a comparison of results from these scales and an assessment of their utility. While it was not possible to predict the outcome between scales there was useful information and insights to be had from each of the experimental approaches (Birch et al., 2007). The complexity of soil organisms and their functioning was collectively summarised in soil quality attributes and a multi-attribute model, and used in assessment of new agricultural technologies including GM crops. We developed a quantitative, multi-attribute, model to summarise the effects of the different cropping systems on soil quality (Bohanec et al., 2007), which has considerable potential for application for other aspects of soil management. The concept and approach of ECOGEN was to combine and integrate the ecological and economic information to give an overall outcome. In conclusion, Bt-maize did not have deleterious effects on the soil biota. When effects were observed these were likely to be caused by differences between the maize varieties. Bt-maize in the agricultural systems studied did not decrease soil quality due to the GM crop itself, but changes in the agricultural techniques used along with the GM crop could improve (reduced tillage) or reduce (increased use of pesticides) the soil quality.

EFSA (2006): No conclusive evidence has yet been presented that currently approved CRY1Ab-expressing GM crops including MON810 are causing significant direct effects on the soil environment. The effects of CRY1Ab-expressing maize in these experiments were small, if they existed at all. In addition, the available data do not indicate a chain of events that might result in long-term effects. Therefore, it seems likely that in commercial cropping conditions, where crop rotations are used, the consequences of effects on soil functions and soil organisms are negligible. There have been no reports of soil function problems in countries where CRY1Ab-expressing crops have been cultivated continuously for several years. The GMO Panel is thus of the opinion that the risk of MON810 maize to soil function and soil organisms is negligible.

Lilley et al. (2006): Farmers and growers continually monitor their soil in terms of nutritional status and pH, structure (i.e. does it become waterlogged or compacted), and function (do crop residues fail to decompose, are there problems with pests and pathogens). These practical observations are related to wider issues of soil quality and provide a set of workable indicators related to essential services.

Icoz, I., Stotzky, G. (2007): Ähnliche Resultate wie bei MON810 finden sich auch bei anderen Bt-Toxinen und Maispflanzen: The Cry3Bb1 protein, insecticidal to the corn rootworm complex (*Diabrotica spp*.), of Bacillus thuringiensis (Bt) subsp. kumamotoensis was released in root exudates of transgenic Bt corn (event MON863) in sterile hydroponic culture and in nonsterile soil throughout growth of the plants. Soils were analyzed for the presence of the protein every 7 to 10 days with a western blot assay (ImmunoStrip) and verified by ELISA. Persistence of the protein varied with the type and amount of clay mineral and the pH of the soils and increased as the concentration of K was increased but decreased as the concentration of M was increased. Persistence decreased when the pH of the K-amended soils was increased from ca. 5 to ca. 7 with CaCO3: the protein was not detected after 14 and 21 days in the pH-adjusted 3K and 6K soils, respectively, whereas it was detected after 40 days in the 3K and 6K soils not adjusted to pH 7. The protein was detected for only 21 days in the 3M soil and for 14 days in the 6M soil, which were not adjusted in pH. These results indicate that the Cry3Bb1 protein does not persist or accumulate in soil and is degraded rapidly

Conclusion: In studies over several years, no accumulation of the Bt toxin or

harmful effects on soil life could be measured.

(4) Effects on non-target organisms on the cultivation areas and in affected ecosystems near the cultivation areas,

Prasifka et al.: Monarch butterfly larvae exposed to Bt MON 810 anthers spent more time off milkweed leaf disks than those exposed to no anthers and were more likely to move off the leaf than larvae exposed to non-Bt anthers. Results suggest that larvae exposed to Bt anthers behave differently and that ingestion may not be the only way Bt can affect nontarget insects like the monarch butterfly. It is unclear whether the changed behavioral measures (increased time spent off leaf disks and increase frequency of larvae moving off leaf disks) would translate into changes in behavior on intact milkweed plants in the field. In our somewhat artificial laboratory experiment, a larva exposed to Bt anthers had a choice between spending time on a small area of milkweed leaf with a high density of anthers or spending time on clear agar. Larvae also were forced to feed on the upper side of the leaf and encounter anthers. On a milkweed plant in the field, the larva would have the choice to move to another area of the same leaf with a lower density of anthers, move to the underside of the leaf where there are no anthers, move to another leaf on the same plant, or move to another plant.

Habustova et al (2006, 2007). The aim of our study was to assess the environmental impact of Bt maize MON 810 in comparison with the parental non-transgenic cultivar. Enzyme-linked immunosorbent assay (ELISA) was used to quantify the amount of Bt toxin CrylAb in the plants. Selected components of the ecosystem were followed during the vegetation season in three successive years, with focus on the plant-dwelling insects and on the communities of epigeic insects and spiders. The examined species included target and non-target herbivores and predators. The results were evaluated for each sample date and finally for the entire experimental period. The study revealed no significant negative effect of Bt maize on the plant dwelling non-target insects and on the epigeic beetles and spiders.

Gathmann et al. 2006: Die Kohlmotte *Plutella xylostella,* die sich in den Versuchen mit Bt176 als besonders empfindlich erwiesen hat, wird durch Pollen der Maislinie MON810 nicht geschädigt. In dreijährigen Freilanduntersuchungen in Deutschland wurden keine negativen Auswirkungen durch den MON810 Mais festgestellt (Gathmann et al. 2006). Ein Risiko von MON810 Mais lässt sich aus dem Wissensstand Nichtzielorganismen aus Sicht des BVL nicht ableiten.

Plutella xylostella was the most susceptible species known to Cry1Ab Bt toxin with a calculated LC50 of 19.2 consumed Bt176 maize pollen grains. The presented study with Mon810 by Gathmann et al. 2006 did not indicate any adverse effect of Bt maize to nontarget lepidopteran larvae even for P. xylostella compared to laboratory and semifield studies. However, Adverse effects of insecticide application to lepidopteran larvae were detected.

Clark et al. (2006): Laboratory studies were conducted to investigate the subacute effects of transgenic Cry1Ab (MON810) maize leaf material on the terrestrial isopods *Trachelipus rathkii* and *Armadillidium nasatum*. These results indicate that little hazard to T. rathkii and A. nasatum from MON810 maize. However, nutritional differences in corn hybrids contributed to differences in isopod growth.

EFSA (2006): The risk of MON810 pollen to non-target lepidopteran species is negligible due to its low CRY1Ab content and the low levels of exposure of wild species to maize pollen.

Flachowsky et al. (2007) (to be considered for impact assessment on non-target higher animals): The authors conclude in their review that in agreement with more than 100 animal studies available to date, results show no significant differences in the nutritional value of feeds from GMP of the first generation in comparison with non-GMP varieties.

Sanden et al. (2007) (to be considered for impact assessment on non-target higher animals): Although the inclusion of genetically modified (GM) plants in diets fed to fish is a contentious issue, there are few empirical data. The present study addressed nutritional value and potential risks of four maize types (two traditional and two GM maize varieties – one is MON810) and two soy types (one traditional and one Roundup Ready soy) included at moderate levels in diets fed to Atlantic salmon parr All diets supported good growth and showed no evidence of diet-related mortality. Based on samplings every 6th week, growth was within the normal range and at conclusion of the study body weight did not differ among any of the treatments (range 101–116 g). Besides minor differences on heptatosomatic index (HSI), plasma triacylglycerol (TAG) values and thermal growth coefficient (TGC), body composition, relative organ weights, plasma nutrient concentrations and enzyme activities did not vary among treatments at any sampling. The present findings indicate that the inclusion of GM plants at the given level in salmonid diets poses little, or no, adverse risk to the health of first feeding Atlantic salmon parr and promote normal growth.
Conclusion: No harmful effects of MON810 Bt toxins on nontarget organisms could be measured in field conditions.

(5) Long-term and large-scale effects on bio-diversity
Birch et al. (2007): The authors report on overall effects on soil biodiversity within the ECOGEN project. They conclude that taking the overall variation found in maize ecosystems at different sites into account, any negative effects of Bt maize at field scale were judged to be indirect and no greater than the impacts of crop type, tillage and pesticide use.

EFSA (2006): There are considerable data on the long-term ecological and biodiversity effects of CRY1Ab-expressing maize. Dolezel et al. (2006) concluded that there is no evidence of environmental harm from CRY1Ab-expressing maize and that only long-term monitoring studies of commercialised crops could provide data sufficient to indicate ecological impact. The GMO Panel is of the opinion that MON810 maize poses no specific significant risk to the environment or to human health compared with other maize types.

Marvier et al. 2007: A meta-analysis of 42 field experiments indicates that nontarget invertebrates are generally more abundant in Bt cotton and Bt maize fields than in nontransgenic fields managed with insecticides. However, in comparison with insecticide-free control fields, certain nontarget taxa are less abundant in Bt fields.

Toschki et al. (2007): No detrimental effect of the cultivation of Bt maize was observed for either spiders or carabid beetles in a 3-yr study.

BVL: Aus methodischen Gründen sind Freilanduntersuchungen zur Erfassung nur für mittlere oder starke Effekte des Bt-Mais sinnvoll. In den letzten 12 Monaten sind eine Reihe von Untersuchungen veröffentlicht worden, die aus Sicht des BVL akzeptable Versuchsbedingungen aufweisen (Eizaguerra et al. 2006, Eckert al. 2006, Gathmann et al. 2006). In einem Teil der Studien konnte nachgewiesen werden, dass einerseits konventionelle Insektizidbehandlungen viele Nichtzielorganismen schädigen, andererseits der Anbau von Bt-Mais keinen nachhaltigen Effekt auf Nichtzielorganismen hatte. Es konnten bei Romeis et al. (2006) nur dort negative Effekte nachgewiesen wurden, wo (1) die Beutetiere der Räuber mit Bt-Toxinen gefüttert wurden und (2) die Beutetiere gegenüber dem Toxin sensitiv waren. In Fällen, in denen das Toxin in einer künstlichen Diät an die Räuber verfüttert wurde, konnten keine Effekte nachgewiesen werden. Die Autoren schlussfolgern, dass die beobachteten Effekt auf eine verringerte Nahrungsqualität der Beutetiere und nicht auf eine direkte toxische Wirkung der Cry-Toxine zurückzuführen ist.
Es konnte gezeigt werden, dass Florfliegenlarven keine Rezeptoren für die Toxinbindung besitzen und somit eine direkte Wirkung des Toxins mit hoher Wahrscheinlichkeit ausgeschlossen werden kann (Rodrigo-Simón et al 2006).
Conclusion: Long-term and large-scale effects on bio-diversity of MON810 cultivation are highly unlikely.

(6) Issue of transgenic organisms remaining in organisms and environmental media (by persistence and accumulation)

Alexander et al. (2007): In their review, Alexander et al. (2007) report that to date there have been no adverse effects in animals consuming commercialized GM crops. Studies undertaken to address concerns that transgenic protein or DNA may enter the market by means of animal products have shown that recombinant materials in transgenic feed are unlikely to be incorporated into animal products at significant levels. Absorption of plant DNA across the intestinal barrier in food animals does seem to be a normal occurrence when DNA fragments are present at high concentrations. Absorption of DNA does not appear to have adverse effects on livestock, whether the DNA is transgenic or endogenous. The fate of recombinant molecules in the currently registered GM plants need not be included in feed safety assessments.

Douville et al. (2007): The aims of this study were to examine the occurrence and persistence of the cry1Ab gene from Btk and Bt corn in aquatic environments near fields where Bt corn was cultivated. The cry1Ab gene persisted for more than 21 and 40 days in surface water and sediment, respectively. The removal of bacteria by filtration of surface water samples did not significantly increase the half-life of the transgene, but the levels were fivefold more abundant than those in unfiltered water at the end of the exposure period. In sediments, the cry1Ab gene from Bt corn was still detected after 40 days in clay and sand-rich sediments. Field surveys revealed that the cry1Ab gene from transgenic corn and from naturally occurring Bt was more abundant in the sediment than in the surface water. The cry1Ab transgene was detected as far away as 82km downstream from the corn cultivation plot, suggesting that there were multiple sources of this gene and/or that it undergoes transport by the water column. Sediment-associated cry1Ab gene from Bt corn tended to decrease with distance from the Bt cornfield. Sediment concentrations of the cry1Ab gene were significantly correlated with those of the cry1Ab gene in surface water. The data indicate that DNA from Bt corn and Bt were persistent in aquatic environments and were detected in rivers draining farming areas. However, the levels of Cry1Ab protein in our samples were below the detection limit most of the time, although it was detected at concentrations ranging from 0.1 to 1 ng/g or ng/ mL in sediment and surface water, respectively.

Lutz et al. (2006): Maize silage is commonly used as feed for farm animals. The aim of this study was to monitor the time-dependent degradation of non-recombinant chloroplast DNA (exemplified by the rubisco gene) in comparison with the recombinant cry1Ab gene (Bt 176) in the course of the ensiling process. In conclusion, the ensiling process markedly decreases the presence of long functional cry1Ab gene fragments and full size Cry1Ab protein.

Nguyen H.T., & Jehle, J.A. (2007): Die gewebespezifische Expression und die saisonale Verbreitung des Cry1Ab-Proteins in transgenen Maispflanzen (Mon810, Sorte „Novelis“) wurde in zwei Feldversuchen bei Bonn und Halle untersucht. Insgesamt wurden 1085 Proben mit Hilfe des Double Antiserum-Enzyme Linked Immunosorbent Assay (DAS-ELISA) untersucht. Der Cry1Ab-Gehalt verschiedener Pflanzengewebe (Wurzel, Stängel, oberes Blatt, unteres Blatt, Staubbeutel, Pollen und Korn) wurde in vier verschiedenen Entwicklungsstadien (BBCH19, BBCH30, BBCH61 and BBCH83) in den Jahren 2001, 2002 und 2003 bestimmt. Die Blätter von Mon810 zeigten den höchsten Cry1Ab-Gehalt (5.5 – 6.4 µg g–1 Frischgewicht [FG] bei BBCH83), während die Pollen mit 1 – 97 ng g–1 FG den geringsten Gehalt aufwiesen. Der Cry1Ab-Gehalt auf dem Feld verbliebener Wurzeln betrug neun Monate nach der Ernte 15 – 17 ng g–1 FG, also nur etwa ein Hundertstel des Gehalts frischer Maiswurzeln. Die Expression des Cry1Ab-Proteins variierte gravierend zwischen einzelnen Maispflanzen.

Nguyen H.T., & Jehle, J.A. (2007): The tissue-specific expression and seasonal abundance of Cry1Ab protein were determined in transgenic maize plants (Mon810, variety ‘Novelis’) from two field trials located near Bonn and Halle, Germany. A total of 1085 samples were analysed by using Double Antiserum-Enzyme Linked Immunosorbent Assay (DAS-ELISA). The Cry1Ab contents of various plant tissues (root, stem, upper leaf, lower leaf, anther, pollen and kernel) were determined at four different growth stages (BBCH19, BBCH30, BBCH61 and BBCH83) collected in 2001, 2002 and 2003. Mon810 showed the highest Cry1Ab contents in the leaves (5.5 – 6.4 µg g–1 fresh weight [fw]) at BBCH83, whereas the lowest Cry1Ab contents were detected in the pollen (1 – 97 ng g–1 fw). Cry1Ab content of residual root stocks collected in the field nine months after harvest was 15 – 17 ng g–1 fw. This demonstrated that the Cry1Ab concentration in residual root stocks was reduced to about one-hundredth of the fresh roots. The monitoring of Cry1Ab expression showed that the Cry1Ab contents varied strongly between different plant individuals. In conclusion, our analyses are the first large-scale expression monitoring of Cry1Ab under European field conditions and provide a comprehensive data set of the temporal distribution of Cry1Ab in transgenic maize Mon810. Cry1Ab expression was lowest in pollen, very low in the stalks, low in roots, but highest in the leaves. Although our studies corroborate the tendencies of reported Cry1Ab contents of Mon810 (AGBIOS 2001, MENDELSOHN et al. 2003), a considerable variation in the expression levels of Cry1Ab was observed. The observed variation exceeds variation levels reported previously and may be due to the large number of analysed samples and different growing years. They suggest a certain plant to plant variation in Cry1Ab expression. Cry1Ab levels also varied in different plant tissues of Mon810 at different growth stages. The overall small differences but similar patterns of Cry1Ab levels at the two filed sites “Bonn” and “Halle” clearly indicate that plant tissue and plant development are the main parameters affecting the Cry1Ab contents of transgenic Mon810.

Ramirez-Romero et al. (2007): Overall, the results of the present study showed that, as expected, purified Cry1Ab protein had dose-related deleterious effects on the Lepidoptera *Spodoptera frugiperda* survival, weight, and development times within 6 d of exposure. Its quality as a host for the parasitoid *Cotesia marginiventris*, assessed as larval weight and size, was significantly reduced under both of the Cry1Ab protein levels evaluated in the present study, so a hostmediated effect on parasitoid development was expected. However, significant host-mediated effects on *C. marginiventris* were not detected under either of the Cry1Ab protein levels evaluated, although high host mortality at the highest Cry1Ab level (182.6 mg Cry1Ab/ml diet) (effects on *C. marginiventris* not evaluated at this Cry1Ab level) would likely have a significant effect on parasitoid populations in the field. Notably, however, host-mediated effects on *C. marginiventris* were evident when *S. frugiperda* were fed Bt-maize tissue. Parasitoid developmental periods and adult size and egg load were significantly affected despite the relatively low levels of Bt toxin present in hosts. Particularly noteworthy was the finding that adult sizes, and so egg loads, were smaller in C. marginiventris developing on hosts fed Bt- versus conventional maize tissue, independently of host quality. The results of this study suggested that Cry1Ab protein as expressed in Bt-maize may have a direct effect on *C. marginiventris*. However, only one GM Mon810 maize and one control maize variety were tested. The indirect effect through lower host quality can be expected.

Mulder et al. (2006): From laboratory tests, the author's report short Bt-induced ecological shifts in the microbial communities of croplands' soils. However, differences in macro-nutrients of the tested Bt Maize MON810 and the near isogenic comparator does not allow for conclusions without question mark.

Rauschen & Schuphan (2006): It is likely that transgenic Bt-maize will be fed into agricultural biogas plants. The fate of the entomotoxic protein Cry1Ab from MON810 maize was therefore investigated in silage and biogas production-related materials in the utilization chains of two farm-scale biogas plants. The Cry1Ab content in silage exhibited no clear-cut pattern of decrease over the experimental time of 4 months. After fermentation in the biogas plants, the Cry1Ab content declined to trace amounts of around 3.5 ng g-1 in the effluents. The limit of detection of the employed ELISA test corresponded to 0.75 ng Cry1Ab g-1 sample material. Assays with larvae of O. nubilalis showed no bioactivity of the reactor effluents. The utilization of this residual material as fertilizer in agriculture is therefore deemed to be ecotoxicologically harmless.

Wiedemann et al. (2006): The concentration of Cry1Ab protein of ensiled Bt176 corn was only 10% that of whole-plant corn. Ensiled corn Cry1Ab protein decreased to 10% of initial values after 48 h of ruminal incubation. Using an immunoblotting technique, the full-size Cry1Ab protein was only detectable up to 8 h; thereafter, only fragments of approximately 17 and 34 kDa size were found. In conclusion, ruminal digestion decreased the presence of functional cry1Ab gene fragments. It is unlikely that fullsize, functional Cry1Ab protein will be present after 8 h of incubation in the rumen.

Conclusion: The current data on persistence and accumulation of transgenic organisms give no evidence for any possible harmful effects. A specific risk for MON810 maize cannot be found based on these data.

(7) Development of secondary pests

Any change in the occurrence of secondary pest where not reported in the major field trials with MON810 maize (Anderson et al. 2007, Gathmann et al. 2006, Marvier et al. 2007). Farm questionnaires are a powerful tool to detect any changes of secondary pest development (Berensmeier et al. 2006, Mönkemeyer at al. 2006, Schmidt et al. 2006).

Conclusion: No change in the occurance of secondary pests were found.

(8) Modifications of pesticide applications (type of pesticide, volume, frequency and point in time)

Andersen et al. 2007: Within the field trials in the ECOGEN project, A negative correlation between corn-borer infestation and maize yield has previously been demonstrated, and was estimated to be in the range of 2–3% yield loss per larve/plant. It appeared that repeated pesticide application did not provide as good a protection level as the Cry1Ab content of the Bt-maize, since grain size was still significantly reduced in the near isogenic non-Bt-variety and yield also tended to be reduced. Although the latter tendency was not significant, it is in line with the above correlation. In summary, Bt-maize produced a higher grain yield and better grain size than an unsprayed near-isogenic non-Bt-variety, or allowed a significant reduction in pesticide use by saving two times spraying each year while producing the same yield.

Conclusion: A change in pesticide applications is unlikely to occur, also because MON810 maize is not herbicide-resistant.

(9) Impacts on food chains and webs

EFSA (2006): The overall data for effects of MON810 maize on biodiversity indicate that the environmental risks to non-target species are negligible. Genetic modified maize did not have a negative impact on non-target species in the field after six years of CRY1Ab-expressing maize cultivation (Bt176 and MON810 maize) in Spain (Eizaguirre et al., 2006). More aphids and leafhoppers but similar numbers of cutworms and wireworms were counted in Bt versus non-Bt fields. Eizaguirre et al. (2006) observed no difference in the numbers of the most relevant predators in fields containing GM or non-GM maize. No adverse effects of MON810 maize on non-target insects including butterflies were observed during a three-year field study in Germany (Gathmann et al., 2006; Eckert et al., 2006). In these two studies, potential long-term effects were addressed due to the continuous growth of MON810 maize without any crop rotation. The GMO Panel considers that MON810 maize will have effects similar to those of comparable non-GM maize cultivars on the environment. In addition, reports and reviews of studies of the effects of the CRY1Ab protein on biodiversity, including the abundance of non-target and biocontrol species, indicate that significant adverse environmental effects due to CRY1Ab-expressing maize cultivation are unlikely (Dolezel et al., 2006; Eizaguirre et al., 2006; Rodrigo-Simon et al., 2006; Romeis et al., 2006, Szekeres et al. 2006).

Schorling & Freier (2007): Ein sechsjähriges Monitoring (2000-2005) von Nichtziel-Arthropoden im Oderbruch ergab keine hinweise auf schädliche Effekte durch Bt-Mais (Schorling & Freier 2006). Jährliche Schwankungen der Umweltbedingungen, spezifische Charakteristika der Anbaufläche und Populationsdynamik hatte einen grundsätzlich größeren Einfluss auf die Arthropoden-Gemeinschaften als der Anbau von Bt-Mais.

Toschki et al. 2007: The Toschki et al. (2007) study described was based on a field design that met the requirements for statistical evaluation, i.e., randomization and sample size large enough for claiming no meaningful change, at least for selected taxa. In this field trial, the activity abundances of spiders and carabid beetles on Bt maize (Novelis, Mon810) plots and insecticide-treated or untreated isogenic control (Nobilis) plots were compared. Samples of these epigeic predators were obtained from the three different maize varieties (eight replicates each) during a period of 3 yr, a time frame sufficient to detect medium-term effects. The data were analyzed by several different evaluation methods with respect to consistency and power. Tiered ecological risk assessment is a common analytical method used in ecotoxicology studies, and it also has been discussed as a feasible stepwise approach to reveal the potential risk of GM organisms (Romeis et al. 2006, Andow and Zwahlen 2006). The analytical methods used in this study can be implemented both for higher-tier testing on a field scale to prospectively assess the potential risks of GM crops and for retrospectively evaluating their potential long-term effects. Furthermore, in contrast to usual crop management practice, the maize fields were not deeply lowed after harvest; instead, the litter was mulched and superficially grubbed. Although such changes could have affected species abundances over the course of the study, the advantages of this approach were the accumulation of plant residues and thus of Bt protein in the soil, with potential reinforcement of any Bt protein effect. No accumulation of Bt protein in the soil was observed. In summary, no detrimental effect of the cultivation of Bt maize was observed for either spiders or carabid beetles in a 3-yr study. Differences that were detected for some species in the first year were caused by a high corn borer infestation followed by microclimate changes.

Marvier et al. 2007: Although scores of experiments have examined the ecological consequences of transgenic Bacillus thuringiensis (Bt) crops, debates continue regarding the nontarget impacts of this technology. Quantitative reviews of existing studies are crucial for better gauging risks and improving future risk assessments. To encourage evidence-based risk analyses, we constructed a searchable database for nontarget effects of Bt crops. A meta-analysis of 42 field experiments indicates that nontarget invertebrates are generally more abundant in Bt cotton and Bt maize fields than in nontransgenic fields managed with insecticides. However, in comparison with insecticide-free control fields, certain nontarget taxa are less abundant in Bt fields. Regardless of one's philosophical perspective on risk assessment for GM crops, enough experimental data has accumulated to begin drawing empirically based conclusions, as opposed to arguing on the basis of anecdote or handpicked examples.

Leslie et al. 2007: Many ecological studies have focused on the effects of transgenes in field crops, but few have considered multiple transgenes in diversified vegetable systems. We compared the epigeal, or soil surface-dwelling, communities of Coleoptera and Formicidae between transgenic and isoline vegetable systems consisting of sweet corn, potato, and acorn squash, with transgenic cultivars expressing Cry1(A)b, Cry3, or viral coat proteins. Vegetables were grown in replicated split plots over 2 yr with integrated pest management (IPM) standards defining insecticide use patterns. More than 77.6% of 11,925 insects from 1,512 pitfall traps were identified to species, and activity density was used to compare dominance distribution, species richness, and community composition. Measures of epigeal biodiversity were always equal in transgenic vegetables, which required fewer insecticide
applications than their near isolines. There were no differences in species richness between transgenic and isoline treatments at the farm system and individual crop level. Dominance distributions were also similar between transgenic and isoline farming systems. Crop type, and not genotype, had a significant inßuence on Carabidae and

Staphylinidae community composition in the first year, but there were no treatment effects in the second year, possibly because of homogenizing effects of crop rotations. Communities were more inßuenced by crop type, and possibly crop rotation, than by genotype. The heterogeneity of crops and rotations in diversified vegetable farms seems to aid in preserving epigeal biodiversity, which may be supplemented by reductions in insecticide use associated with transgenic cultivars.

Sanvido et al. 2006: The risks of GM crops for the environment, and especially for biodiversity, have been extensively assessed worldwide over the past 10 years of commercial cultivation of GM crops. Consequently, substantial scientific data on environmental effects of the currently commercialized GM crops are available today, and will further be obtained given that several research programmes are underway in a number of countries. The data available so far provide no scientific evidence that the commercial cultivation of GM crops has caused environmental impacts beyond the impacts that have been caused by conventional agricultural management practices. Nevertheless, a number of issues related to the interpretation of scientific data on effects of GM crops on the environment are debated controversially. To a certain extent, this is due to the inherent fact that scientific data are always characterized by uncertainties, and that predictions on potential long-term or cumulative effects are difficult. Uncertainties can either be related to the circumstance that there is not yet a sufficient data basis provided for an assessment of consequences (the "unknown"), or to the fact that the questions to solve are out of reach for scientific methods (the "unknowable"). There is thus a need to develop scientific criteria for the evaluation of effects of GM crops on the environment in order to assist regulatory authorities when deciding whether environmental effects of GM crops are considered to represent a relevant environmental impact. Agricultural production systems are complex and diverse. As with the adoption of any new technology, the use of agricultural biotechnology might include positive and possibly less favorable environmental impacts. GM cropping systems can help to reduce some environmental impacts associated with conventional agriculture, but they will also introduce new challenges that must be addressed. When discussing the risks of GM crops, one has to rec ognize that the real choice for farmers and consumers is not between a GM technology that may have risks and a completely safe alternative. The real choice is between GM crops and current conventional pest and weed management practices, all possibly having positive and negative outcomes. To ensure that a policy is truly precautionary, one should therefore compare the risk of adopting a technology against the risk of not adopting it. We thus believe that both benefits and risks of GM crop systems should be compared with those of current agricultural practices.

Sisterson et al. 2007: Widespread planting of transgenic insecticidal (TI) crops for pest control has raised concerns about potential harm to nontarget arthropods. Because the first generation of TI crops produce single Bacillus thuringiensis (Bt) toxins causing little or no harm to most nontarget arthropods, they are not likely to cause such negative effects. However, varieties of transgenic crops with multiple Bt toxins or novel toxins might be more harmful to nontarget arthropods.

Schuler (2007): An extensive body of research data has been assembled on non-target impacts of the Cry1Ab expressing maize events MON810, 176 and Bt11. One important lesson is that minor negative effects observed in the laboratory do not necessarily translate into impacts in the field where many other factors affect the fitness of non-target species (including climate, food availability and predation). The majority of studies do not show any unexpected negative effects on non-target insects or ecosystem functions. For some of the maize events further information on the susceptibility and potential exposure of non-target insects as well as more extensive field trial data would be desirable to increase confidence in the biosafety of the new events. Of particular concern are the relatively high Bt protein levels in pollen of several of the new Bt maize events. Bt toxin expression in pollen has long been controversial as it increases exposure of non-target insects. Scientists have also expressed concern that understanding of the impacts Bt toxins on soil functions is still limited. Environmental risk assessment studies carried out by applicants currently differ in many respects, including the scale and scope of field studies conducted, appropriateness of indicator species chosen and the extent to which impacts on soil organisms were investigated. It is recommended that standardised guidance is developed regarding the required approaches and standards for non-target studies for the environmental risk assessment of GM crops in the EU.

Woiwood & Schuler (2007) Scientific evidence strongly suggests that the GM crops grown so far are not in themselves more hazardous to the environment than those produced by conventional breeding. Studies have repeatedly demonstrated that the significant factors are the trait and management of the crop, not the breeding method itself.

Conclusion: No harmful effects of MON810 Maize on the food chains and webs could be identified

References:

Alexander, T.W., Reuter, T., Aulrich, K. Sharma R., Okine, E.K., Dixon, W.T. McAllister, T.A. (2007) A review of the detection and fate of novel plant molecules derived from biotechnology in livestock production. Animal Feed Science and Technology 133, 31–62

Andersen, M.N., Sausse, C., Lacroix, B., Caul, S., Messean, A., (2007) Agricultural studies of GM maize and the field experimental infrastructure of ECOGEN. Pedobiologia, in press.

Andow, D.A., Birch, A.N.E., Dusi, A.N.E., Fontes, M.G., Hilbeck, A., Lang, A., Lövei, G.L., Pires, C.S.S., Sujii, E.R., Underwood E., Wheatley, R.E. (2006) Non-target and biodiversity risk assessment for genetically modified (GM) crops. In: Proceedings of the Ninth International Symposium on the Biosafety of Genetically Modified Organisms, Korea, September 2006, pp. 68–73. http://www.gmo-guidelines.info/public/publications/download/Andowetal2006_ISBR.pdf

Andow D.A. & Hillbeck A. (2006) Science-based risk assessment for nontarget effects of transgenic crops. BioScience 54, 637-649.

Andow D.A. & Zwahlen C.(2006) Assessing environmental risks of transgenic plants. Ecological Letters 9, 196-214.

Berensmeier, A., Schmidt, K., Beißner, L., Schiemann, J., Wilhelm, R. (2006) Statistical analysis of fram questionaires to search for differences between GM- and non-GM maize. J. Verbr. Lebensm. 1, Suppl 1, 80-884.

Birch, A.N.E., Griffiths, B.S., Caul, S., Thompson, J., Heckmann, L.H., Krogh, P.H. (2007) The role of laboratory, glasshouse and field scale experiments in understanding the interactions between genetically modified crops and soil ecosystems. Pedobiologia, in press.

Bohanec, M., Cortet, J., Griffiths, B., Znidarsic, M., Debeljak, M., Caul, S., Thompson, J., Krogh, P.H., (2007) A qualitative multi-attribute model for assessing the impact of cropping systems on soil quality. Pedobiologia, in press.

Brookes, G. (2007) The benefits of adopting genetically modified, insect resistant (Bt) maize in the European Union (EU): first results from 1998-2006 plantings. PG Economics Ltd. www.pgeconomics.co.uk

Chapman, M.A. & Burke, J.M. (2006) Tansley review - Letting the gene out of the bottle: the population genetics of genetically modified crops New Phytologist 170, 429–443.

Clark, B.W., Prihoda, K.R., Coats J.R. (2006) Subacute effects of transgenic Cry1Ab *Bacillus thuringiensis* corn litter on the isopods *Trachelipus rathkii* and *Armadillidium nasatum*. Environmental Toxicology and Chemistry, Vol. 25, No. 10, pp. 2653–2661.

Cortet, J., Griffiths, B.S., Bohanec, M., Demsar, D., Neumann, M., Andersen, M.N., Caul, S., Birch, A.N.E., Pernin, C., Tabone, E., de Vaufleury, A., Ke, X., Henning Krogh, P., 2007. Evaluation of effects of transgenic Bt maize on microarthropods in a European multi-site experiment. Pedobiologia, in press.

Cortet, J., Andersen, M.N., Caul, S., Griffiths, B.S., Joffre, R., Lacroix, B., Sausse, C., Thompson, J., Krogh, P.H. (2006). Decomposition processes under Bt (Bacillus thuringiensis) maize: results of a multi-site experiment. Soil Biol. Biochem. 38, 195–199.

De Vaufleury, A., Kramarz, P.E., Binet, P., Cortet, J., Caul, S., Andersen, M.N., Plumey, E., Coeurdassier, M., Krogh, P.H. (2007) Exposure and effects assessments of Bt-maize on non-target organisms (gastropods, microarthropods, mycorrhizal fungi) in microcosms, Pedobiologia, in press

Dannemann, K. (2006) Biologische Verfahren oder Insektizid? Maiszünslerbekämpfung lohnt sich. Mais 1, 28-30.

Dolezel, M., Heissenberger, A., and Gaugitsch, H., 2006. Ecological effects of genetically modified maize with insect resistance and/or herbicide tolerance. Literature research report on behalf of the Bundesministerium für Gesundheit und Frauen, Wien, Austria. 64 pp. http://www.bmgf.gv.at/cms/site/attachments/5/6/2/CH0255/CMS1134457515326/literaturstudie_mais_endbericht.pdf

Douville, M., Gagné, F., Blaise, C., André, C. (2007) Occurrence and persistence of Bacillus thuringiensis (Bt) and transgenic Bt corn cry1Ab gene from an aquatic environment. Ecotoxicol Environ Saf. 66:195-203.

Eckert J, Schuphan I, Hothorn LA & Gathmann A (2006) Arthropods on maize ears for detecting impacts of Bt maize on nontarget organisms. Environ. Entomol. 35: 554-560.

EFSA (2004) Guidance document of the scientific panel on genetically modified organisms for the risk assessment of genetically modified plants and derived food and feed – The EFSA Journal 99: 1-94.

EFSA (2006) Opinion of the Scientific Panel on Genetically Modified Organisms on a request from the Commission related to the safeguard clause invoked by Greece according to Article 23 of Directive 2001/18/EC and to Article 18 of Directive 2002/53/EC, The EFSA Journal 411, 1-26. http://www.efsa.europa.eu/etc/medialib/efsa/science/gmo/gmo_opinions/ej411_greek_safeguard.Par.0003.File.dat/gmo_op_ej411_Greek_safeguard_clause_MON810maize_en.pdf

El-Bendary, M.A. (2006) *Bacillus thuringiensis* and *Bacillus sphaericus* biopesticides production. J. Basic Microbiol. 46, 158–170.

Flachowsky, G., Aulrich, K., Böhme, H., Halle, I. (2007) Studies on feeds from genetically modified plants (GMP) – Contributions to nutritional and safety assessment. Animal Feed Science and Technology 133, 2–30.

Gathmann, A., Wirooks, L., Hothhorn, L., Bartsch, D., Schuphan, I. (2006) Impact of Bt-maize pollen (MON810) on lepidopteran larvae living on accompanying weeds, Molecular Ecology, 15, 2677–2685.

Griffiths, B.S., Caul, S., Thompson, J., Birch, A.N.E., Scrimeour, C., Cortet, J., Foggo, A., Hackett, C.A., Krogh, P.H., 2006. Soil microbial and faunal community responses to Bt-maize and insecticide in two soils. J. Environ. Qual. 35, 734–741.

Griffiths, B.S., Heckmann, L.H., Caul, S., Thompson, J., Scrimgeour, C., Krogh, P.H. (2007a). Varietal effects of eight paired lines of transgenic Bt-maize and nearisogenic non-Bt maize on soil microbial and nematode community structure. Plant Biotechnol. J. 5, 60–68.

Griffiths, B.S., Caul, S., Thompson, J., Birch, A.N.E., Cortet, J., Andersen, M.N., Krogh, P.H., (2007b) Microbial and microfaunal community structure in cropping systems with genetically modified plants. Pedobiologia, in press.

Hardwood, J.D., Obrycki, J.J. (2006) The detection and decay of Cry1Ab Bt-endotoxins within non-target slugs, *Deroceras reticulatum* (Mollusca: Pumonata), following consumption of transgenic corn. Biocontrol Sci. Technol. 16, 77–88.

Harwood, J.D., Samson, R.A., Obrycki J.J. (2006) No evidence for the uptake of Cry1Ab Bt-endotoxins by the generalist predator Scarites subterraneus (Coleoptera: Carabidae) in laboratory and field experiments. Biocontrol Sci. Technol. 16: 377-388.

Heckmann, L.H., Griffiths, B.S., Caul, S., Thompson, J., Pusztai-Carey, M., Andersen, M.N., Krogh, P.H. (2006) Consequences for *Protaphora armata* following exposure to genetically modified Bt maize and non-Bt maize. Environ. Pollut. 142, 212–216.

Habustová O., Turanli F., Dolezal P., Rúzicka V., Spitzer L., Hussein H.M. (2006) Environmental impact of Bt maize – three year experience. IOBS wprs Bulletin pp.57-63.

Habustová O., Dolezal P., Hussein H.M., Spitzer L., Turanli F., Rúzicka V., Sehnal F. (2007) Lack of effect of maize expressing bacterial toxin Cry1Ab on the composition of insect communities. 3rd EIGMO Meeting; Ecological Impact of Genetically Modified Organisms (EIGMO), 23-25 May 2007, Warsaw, Poland. pp.40.

Icoz, I., Stotzky, G. (2007) Cry3Bb1 protein from Bacillus thuringiensis in root exudates and biomass of transgenic corn does not persist in soil, Transgenic Research, September 13 http://www.springerlink.com/content/pm447n1340n136t3/?p=983f4101bc97459596ce768d9dc6407a&pi=5

Krogh, H., and Griffiths B. (2007) ECOGEN – Soil ecological and economic evaluation of genetically modified crops. Pedobiologia, in press.

Krogh, P.H., Griffiths, B., Demsˇar, D., Bohanec, M., Debeljak, M., Andersen, M.N., Sausse, C., Birch, A.N.E., Caul, S., Holmstrup, M., Heckmann, L.H., Cortet, J. (2007) Responses by earthworms to reduced tillage in herbicide tolerant maize and Bt maize cropping systems. Pedobiologia, in press.

Leslie, T.W., Hoheisel, G.A., Biddinger, D.J., Rohr, J.R., Fleischer, S.J. (2007) Transgenes sustain epigeal insect biodiversity in diversified vegetable farm systems. Environ. Entomol. 36(1): 234-244.

Lilley, A.K., Bailey, M.J., Cartwright, C., Turner, S.L., Hirsch, P.R. (2006). Life on earth: the impact of GM plants on soil ecology? Trends Biotech. 24, 9–14.

Lutz, B., Wiedemann, S., Albrecht C. (2006) Degradation of transgenic Cry1Ab DNA and protein in Bt-176 maize during the ensiling process. Journal of Animal Physiology and Animal Nutrition 90 (2006) 116–123.

Marvier, M., McCreedy, C., Regetz, J., Kareiva, P. (2007) A Meta-Analysis of Effects of Bt Cotton and Maize on Nontarget Invertebrates . Science VOL 316, 1475-1477.

McHughen, A. (2006) Editorial - The limited value of measuring gene flow via errant pollen from GM plants. Environ. Biosafety Res. 5 (2006) 1–2.

Mulder, C., Wouterse, M., Raubuch, M., Roelofs, W., Rutgers, M. (2006) Can transgenic maize affect soil microbial communities. PLoS Computational Biology 2: 1165-1172.

Mönkemeyer W., Schmidt, K., Beißner, L., Schieman, J., Wilhelm, R. (2006) A critical examination of the potentials of existing German networks for GMO-Monitoring. J. Verbr. Lebensm. 1, Suppl 1, 67-71.

Nguyen H.T., & Jehle, J.A. (2007) Quantitative analysis of the seasonal and tissue-specific expression of Cry1Ab in transgenic maize Mon810. Journal of Plant Diseases and Protection, 114 (2), 82–87.

Obrist, L. B., A. Dutton, R. Albajes, and F. Bigler (2006) Exposure of arthropod predators to Cry1Ab toxin in Bt maize fields. Ecol. Entomol. 31: 143-154.

ORAMA (2007) GM Maize in the field: conclusive results. The General Association of Maize Growers. http://www.agpm.com/iso_album/resultats_techniques_maisbt_2006.pdf

Prasifka, P.L., Hellmich, R.L., Prasifka, J.R., Lewis, L.C. (2007) Effects of Cry1Ab-Expressing Corn Anthers on the Movement of Monarch Butterfly Larvae. Environ. Entomol. 36(1): 228-233.

Ramirez-Romero, R., Bernal, J.S., Chaufaux, J., Kaiser, L. (2007) Impact assessment of Bt-maize on a moth parasitoid, Cotesia marginiventris (Hymenoptera: Braconidae), via host exposure to purified Cry1Ab protein or Bt-plants. Crop Protection 26, 953–962.

Rauschen S. & Schuphan, I. (2006) Fate of the Cry1Ab protein from Bt-maize MON810 silage in biogas production facilities. J. Agric. Food Chem. 2006, 54, 879-883.

Rodrigo-Simón A., de Maagd R.A., Avilla C., Bakker P.L., Moltoff J., González-Zamora J.E., Ferré J. (2006) Lack of detrimental effects of *Bacillus thuringiensis* Cry toxins on the insect predator Chrysoperla carnea: a toxicological, histopathological, and biochemical analysis. Applied and Environmental Microbiology, 72, 1595-1603.

Romeis J., Bartsch D., Bigler F., Candolfi M., Gielkens M., Hartley S.E., Hellmich R.L., Huesing J.E., Jepson P., Layton R., Quemeda H., Raybould A., Rose R.I., Schiemann J., Sears M.K., Shelton A.M., Sweet J., Vaituzis Z., Wolft J.D. (2007). Moving through the tired and methodological framework for non-target arthropod risk assessment of transgenic insecticidal crops. Proceedings of the Ninth International Symposium on Biosafety of Genetically Modified Organisms, Biosafety Research and Environmental Risk Assessment Jeju Island, Korea, 64-69.

Sanden, M., Krogdahl, A., Bakke-Mckellep, A.M., Buddington, R.K., Hemre, G.I. (2006) Growth performance and organ development in Atlantic salmon, *Salmo salar* L. parr fed genetically modified (GM) soybean and maize. Aquaculture Nutrition 2006 12; 1–14.

Sanvido, O., Romeis, J., Bigler, F. (2006) Ecological Impacts of Genetically Modified Crops: Ten Years of Field Research and Commercial Cultivation. Adv Biochem Engin/Biotechnol 107: 235–278.

Scatasta, S., Wesseler, J., Demont, M., Bohanec, M., Dzeroski, S., Znidarsic, M., 2006. Multi-attribute modelling of economic and ecological impacts of agricultural innovations on cropping systems. J. System Cybernet. Informat. 4, 52–59.

Schorling M., Freier B. (2006) Six-year monitoring fo non-target arthropods in Bt maize (cry1Ab) in the European corn borer (*Ostrinia nubilalis*) infestation area Oderbruch (Germany). J. Verbr. Lebensm. 1, Suppl 1, 106-108.

Schröder, G. & Kuntzke, D. (2007) Maiszünslerbekämpfung – Versuchsergebnisse und Erfahrungen aus Brandenburg. Mais 2, 60-63.

Schuler, T. (2007) New Bt toxins in the EU GMO application process: A review of published research into impacts on non-target insects and ecosystem function. DEFRA report 53 pages. http://www.defra.gov.uk/environment/gm/research/pdf/epg-ts1.pdf

Sisterson, M.S., Carriere, Y., Dennehy, T.J., Tabashnik, B.E. (2007) Nontarget Effects of Transgenic Insecticidal Crops: Implications of Source-Sink Population Dynamics. Environ. Entomol. 36(1): 121-127.

Szekeres, D., Kádár, F., Kiss, J. (2006). Activity density, diversity and seasonal dynamics of ground beetles (Coleoptera: Carabidae) in Bt- (MON810) and in isogenic maize stands. Entomol. Fennica, 17, 269-275.

Toschki, A., Hothorn, L.A., Roß-Nickoll, M. (2007) Effects of cultivation of genetically modified Bt maize on epigeic arthropods (Araneae; Carabidae) Environ. Entomol. 36, 966-980.

Vercesi, M.L., Krogh, P.H., Holmstrup, M., (2006) Can Bacillus thuringiensis (Bt) corn residues and Bt-corn plants affect life-history traits in the earthworm Aporrectodea caliginosa? Applied Soil Ecology, 32, 180-187.

Wesseler, J., Scatasta, S., Nillesen, E. (2007) The Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) and other benefits and costs of introducing transgenic maize in the EU-15. Pedobiologia, in press.

Widmer, F. (2007) Assessing effects of transgenic crops on soil microbial communities. Adv Biochem Engin/Biotechnol 107: 207–234.

Wiedemann, S., Lutz, B., Kurtz, H., Schwarz, F.J., Albrecht, C. (2006) In situ studies on the time-dependent degradation of recombinant corn DNA and protein in the bovine rumen. J. Anim. Sci. 2006. 84:135–144.

Woiwood, I.P. & Schuler, T.H. (2007) Genetically Modified Crops and Insect Conservation, Rothamsted Research, in: Insect Conservation Biology: The 22nd Symposium of the Royal Entomological Society (Cabi Publishing) by A J A Stewart, T R New, O T Lewis (Editors) UK Oxford University Press, USA, 480 pp.

Schmidt, K., Beißner, L., Schiemann, J., Wilhelm, R. (2006) Methodology and tools for dataaquisition and statistical analysis. J. Verbr. Lebensm. 1, Suppl 1, 21 – 25.