SUMMARY

Background, objectives and scope

1. If genetically modified (GM) crops eventually increase their share in EU agriculture, adventitious presence of GM varieties in non-GM seeds and crops might become an issue. Therefore there is a need to find appropriate measures at the farm level to minimise adventitious presence of GM crops.
2. The objectives of this study, covering three model crops, are to
   - identify sources and estimate levels of adventitious presence of GM crops in non-GM crops at farm level,
   - identify and assess changes of farming practices that could reduce adventitious presence of GM crops in non-GM crops below policy-relevant thresholds,
   - estimate costs of relevant changes in farming practices, costs of monitoring systems and costs of potential insurance systems to cover possible financial losses due to adventitious presence of GM crops in non-GM crops.
3. The study covers three arable crops, with several farm types for each crop in representa-

   tive production areas of the EU:
   - winter oilseed rape (OSR) for seed production (certified and farm-saved seed) (France, Germany)
   - grain maize for feed production (Italy, France)
   - potato for direct consumption and food processing (UK, Germany)
4. The three model crops have been studied on different conventional and organic farm types, representing the average farm context for each of the different production forms in the selected geographical areas (certified and farm-saved OSR seed, intensive and nonintensive maize cultivation, early and regular potatoes). For a better comparison similar farm and plot sizes have been assumed for conventional and organic farms. Additionally smaller organic farm types have been studied to reflect the actual situation in some Member States.

General Findings

5. Sources of adventitious presence of GM crops in non-GM crops at farm level are seed impurities, spread of pollen and seeds from field to field by wind, insects and machines, overwintering of plants and plants growing from spread seeds as well as mixing of crops after harvest.
6. The percentage of GMOs grown in the region represents an important factor, already a level of 10 % GM varieties in the region causes significant levels of GMO content in non-GM crops. Two scenarios of 10 % or 50 % share of GM crops in the region were analysed. A share of 50 % mimics the current situation in countries which adopted GM crops readily (e.g. in 2000, GM soybeans represented about 54 % of the American soybean acreage, GM rape seed represented about 50 % of the Canadian rape seed acreage) and is the principal scenario examined in the study, while a share of 10 % GMOs illustrates an introduction phase of GM crops in EU agriculture.
7. Farming practises such as the treatment of soil, sowing dates, rotation systems and the infrastructure of the farm, as well as farm and plot size may influence levels of adventitious presence of GM crops in non-GM crops.
8. Threshold levels that have been studied here are 1 % (for maize and potato crops), 0,3 % (for OSR seed production) and 0,1 % (for all three model crops). The two first are thresholds that have been integrated in European legislation or are being discussed in this context. The latter (0,1 %) reflects the quantification limit of current analytical methods and mimics the condition of zero GMO content. The 1 % and 0,3 % threshold can be met in both scenarios studied but with changes in

farming practices needed for any farm types. In certain cases studied, farming practices, which involve a co-operation between neighbouring farms, are the most effective ones. To estimate on-farm levels of adventitious presence of GM crops in non-GM crops and to compare the effects of changing farming practices a combination of expert scientific opinion and computer models was used. The latter provide levels of adventitious presence of GM crops with a relative value (i.e. they are useful for comparisons of farming practices). Their absolute values (e.g. when considering if a particular threshold can be respected) have to be taken with care, since the models are not yet fully validated.

9. The possibilities to meet a very low threshold (0,1 %) were analysed for all three model crops. The results show that compliance with this threshold would be difficult in any of the two scenarios considered, even with significant changes in farming practices. Thus, if applying the very low *de facto* threshold currently required in organic production (detection limit), organic production of GMO-free crops would not be feasible in a region with GM crop production.

10. Compliance with the 1 % threshold would result in additional costs (changing farming practices, monitoring system, insurance) of 1 % - 9 % of current product price for maize and potato. For OSR seed production, the equivalent costs would be 10 % - 41 % of current price. These costs include all identified costs, also those affecting the GM crop production. This reflects the present situation regarding legal obligations for commercial GM crop production.

Specific Findings

Winter oilseed rape for seed production

11. For production of certified or farm-saved seed four organic and conventional farm types are studied. Certified seed producers are assumed to grow OSR according to certified seed production standards (e.g. for hybrid seed an isolation distance of 300 m and a 6 year rotation, careful post-harvest segregation). The farms using farm-saved seed are assumed to be larger (about three times) with larger plots. The conventional farm applies a short 3 year rotation, exchanges seed and shares machinery with its neighbours or uses contractors (for example for harvesting). It has no dedicated machinery for GM crops and no dedicated storage facilities. A summary of farm characteristics, predicted levels of adventitious presence of GM OSR in non-GM OSR, recommended changes in farming practices and related costs is shown in Table A of the Annex to this Summary.

12. For the estimation of in-field levels of adventitious presence of GM crops in non-GM crops the computer model GENESYS has been used. It ranks cropping systems according to their probability for gene flow from herbicide tolerant OSR to rape volunteers, both in time (via seeds) and in space (via pollen and seeds). It is suitable for seed as well as for crop production. Expert opinion was used for estimations of post-harvest levels of adventitious presence of GM OSR.

13. Applying current practices, levels of adventitious presence of GM crops are estimated to range from 0,42 % to 1,05 % for the considered farm types in the presence of 50 % GMOs (see Table A). Organic farm types (with current practices) are predicted to have higher levels of adventitious presence of GM OSR mainly because of their lower efficiency in volunteer control compared with conventional farms (see Table A, current practices). All farm types, organic as well as conventional, could achieve a hypothetical 0,3 % threshold for GMO content in seed production by changing farming practices.

14. Theoretically, levels of adventitious presence of GM crops could be reduced to very low levels (< 0,1 %) by changing farming practices. The only exception would be conventional farms using farm-saved seed, where achieving such low levels seems not to be feasible without changing the post-harvest farming strategy completely (see Table A, best change of practices).

15. Levels of adventitious presence of GM crops depend on field sizes (as shown by studying an additional small farm scenario), isolation distances, volunteer control and the farm structure regarding post-harvest handling of the seed crop (possibility to segregate). In addition, for OSR the initial seed purity and the selected crop variety (varietal associations and hybrids with reduced

male fertility or - for seed production - with male sterile parent lines are very prone to cross-pollination) play an important role.

16. The model predicted as effective measures:
    - Avoiding *at any time* throughout the rotation cycle cultivation of rape seed within a radius of 300 m surrounding the seed production field (costs difficult to estimate due to the need for far-reaching changes of crops and rotations).
    - Changing set-aside management by sowing the field in spring in order to minimise survival of rape volunteers (estimated to 194 €/ha additional costs).
    - Longer rotations with an additional (non-rape) spring crop to control volunteers (no additional costs assumed).
    - Sowing GM OSR one month before non-GM OSR in order to have a difference in flowering time. This farming practice is very effective but not reliable enough because of its dependency on favourable weather conditions.

    The selection of measures depends on the type of farm, but in general changing set-aside management and establishing OSR-free zones of 300 m around the plot are the most efficient practices, though they are rather costly or require co-operation between farmers. The EC Scientific Committee on Plants (SCP), in its opinion from 13 March 2001, recommends an isolation distance of at least 600 m for hybrid seed in the year of seed production to avoid cross-pollination.

Maize for grain production

17. For grain maize production seven farm types were studied (conventional and organic, intensive and non-intensive cultivation, large and small organic farms). Main features of intensive maize cultivation are the high percentage of maize grown (50 % to 80 % of the agricultural area) and varying but generally small isolation distances between different plots. In contrast, farms cultivating maize in non-intensive cultivation regions (maize representing 20 % of the agricultural area) are assumed to have larger plots and isolation distances of about 500 m. A summary of farm characteristics, levels of adventitious presence of GM crops in non-GM crops, recommended changes in farming practices and related costs is shown in Table B of the Annex to this Summary.
18. The computer model MAPOD was used to estimate the effects of changing farming practices on the level of in-field adventitious presence of GM maize in non-GM maize via cross-pollination. Post-harvest levels were estimated by an expert panel.
19. Applying current practices, levels of adventitious presence of GM crops in non-GM crops are estimated to range from 0,16 % to 2,25 % for the considered farm types in the 50 % scenario (see Table B).
20. Cross-pollination from GM plants is the main source of in-field adventitious presence of GM maize. The impact depends on relative plot size of the GM source and the non-GM recipient as well as on isolation distances. Small farms or farms with smaller fields would be more affected. Volunteers in maize are not a significant source of adventitious presence of GM crops.
21. Impurities in the certified seeds used for sowing would also be an important source of adventitious presence of GM crops. According to OECD schemes a varietal purity for conventional certified maize seed of 99,0 % is required. In the study, adventitious presence of GM seed in conventional maize seeds is assumed to be 0 - 0,3 %. For organic seed lower seed impurities could be expected, reflected in the assumed level of 0,05 % in this study.
22. For conventional farms the post-harvest handling of the grains represents another principal source for adventitious presence of GM crops as maize is often cleaned, dried and stored in central facilities, where adventitious admixture could occur.
23. Conventional intensive maize producers may need to change farming practices to comply with a threshold of 1 % (in both scenarios of 10 % or 50 %, and considering an adventitious presence of GM seeds in the seeds used of about 0,3 %). Lowering seed impurity would have a big impact but

might be difficult to achieve (opinion of the SCP from 13 March 2001). Increasing isolation distances to 100 m - 200 m, the introduction of varieties for GM and non-GM maize with different flowering times and improving post-harvest management (storage, cleaning and drying facilities dedicated to non-GM maize) would be possible alternatives. The costs of increasing isolation distances and changing post-harvest management have not been determined because of their very complex nature. For a difference in flowering time to be effective, the GM variety has to flower earlier than the non-GM variety. Because of generally lower yields for earlier varieties, this would lead to additional costs of about 45 €/ha (for GMO producers) (see Table B, best change of practices, additional costs).

24. In less intensive maize growing regions, for conventional farms it may be sufficient to change the post-harvest management to meet a threshold of 1 % (an adventitious presence of GM seed in non-GM maize seed of 0,3 % has been assumed) (see Table B, best change of practices).

25. Organic farms (not growing GM maize on their farms) using organic seed with high purity and having a post-harvest management separated from conventional production, could meet a threshold of 1 % without changing current farming practices.

26. A threshold of 0,1 % seems to be extremely difficult to achieve for any of the farm scenarios.

Potato for fresh consumption and processing

27. Potato has very different characteristics compared to oilseed rape and maize, as the harvested potato is not the result of a fertilisation event. Therefore it has far less problems regarding pollen flow as a source for adventitious presence of GM crops. In four farm types studied (conventional and organic production of early potatoes and potatoes for direct consumption and processing), the main problems are caused by groundkeepers and post-harvest handling of the crop.

28. Expert opinion alone was used to estimate in-field and post-harvest levels af adventitious presence of GM crops in potatoes. Applying current farming practices including a careful segregation of varieties, the estimated levels of adventitious presence of GM crops in non-GM crops range from 0,1 % to 0,54 % (see Table C in the Annex to this Summary).

29. All considered farm types would be able to meet a 1 % threshold without changing farming practices. Organic farms face levels of adventitious presence of GM crops of less than half of those of the conventional farms. However, even with changes in farming practices, a threshold of 0,1 % would probably not be achievable for any farm type. The farm characteristics and results for potato are presented in Table C.

Applicability of existing segregation systems

30. Segregation systems in place (such as those for waxy maize of high erucic acid oilseed rape) are not suitable for the purpose of minimising adventitious presence of GM crops in non-GM crops, without some significant changes. In general the thresholds assured by these systems are less stringent than those being established for GM crops. Also, some of these segregation systems are backed by cheap, fast and easy detection methods (iodine staining for waxy maize) while current methods for detecting and differentiating GM varieties do not yet have these characteristics.

Monitoring adventitious presence of GM crops in non-GM crops on the farm

31. Monitoring systems could be developed adapting the Hazard Analysis and Critical Control. Point methodology (HACCP), to define crucial steps in the production process to be controlled. Different degrees of control intensity, adjusted to thresholds and probability of adventitious GMO presence, could be achieved by varying the production steps to be included. At each stage of the cultivation process, steps to assure segregation have to be documented. The scheme would be supported by detection methods (qualitative and quantitative GMO Polymerase Chain Reaction (PCR) analysis).

32. Detection and quantification of GMO content is usually done by analysing the transgenic DNA by PCR or the protein content by immunoassays (Enzyme-linked ImmunoSorbent Assay, ELISA). These tests are rather time-consuming and need laboratory equipment as well as skilled personal. To enable control of GMO content on the farm level, accurate, cheap, quick and easy to use testing methods based on PCR and ELISA need to be developed. Currently, test prices are in the region of 320 € for a quantitative PCR analysis of a single sample or 150 € for a semi-quantitative analysis of a single sample by ELISA. Prices might decrease when larger numbers of samples are tested.
33. Several national and international organisations are involved in developing harmonised guidelines and standards for sampling strategies and GMO detection methods. Validation of testing methods, especially PCR, is undertaken by performing ring trials with different laboratories. The major initiative in this field in the EU is the European Network of GMO Laboratories, organised by the Joint Research Centre / Institute for Health and Consumer Protection (JRC / IHCP). Certified reference materials for PCR and ELISA tests of specific GMOs have been developed by Joint Research Centre / Institute for Reference Materials and Measurements (JRC / IRMM).

Insurance systems

34. If adventitious presence of GM crops in non-GM crops occurs above a set threshold a reduction of income could be expected. Organic farmers would also lose possible organic price premia and subsidies, so their short-term losses would be higher. Indicative insurance costs have been calculated on the basis of short-term losses and an assumed frequency of exceeding the threshold of 3 %. In the medium and long-term additional costs for crop management to control GM volunteers, for GMO testing and control might arise. For organic farms, to regain the organic status might take time and imply a further loss of income.

Cost impacts

35. Costs presented below are those needed to meet thresholds of 0,3 % for OSR seed and 1 % for maize and potato crops, in the 50 % scenario.
36. Changing farming practices, where necessary, leads to very different economical burdens for farmers according to crop and farm scenario. Costs of monitoring systems have a high impact on all farms. Monitoring costs include a large part that is fixed per farm unit, therefore total costs would be negatively correlated to farm size. Indicative insurance costs have a large impact on most organic farms due to high price premia, and negligible effects on conventional farms. Differences in yields and prices between crops lead to dramatic differences in economic impact, although the costs per ha may be of similar magnitude. This is illustrated in Figure A of the Annex, which presents total costs as percentage of product price.
37. For OSR, farms producing conventional certified seeds would have additional costs representing 10 % of the price, the largest part of the costs being monitoring costs. For the corresponding organic farm, costs would represent more than 20 % of the price, the difference being due to higher costs of changing agricultural practices. For seed saving farms, the costs would represent 17 % (conventional) or 41 % (organic) of the price, the organic farm having to apply a more expensive additional farming practice. These farms would probably be forced to stop saving seed and instead buy certified seed.
38. For maize additional costs for intensive conventional production would correspond to 9 % of the price, with almost half the costs originating from yield losses due to change of flowering time. However, costs of necessary changes of the post-harvest management for conventional farms have not been estimated in this study. For an organic farm located in the same area, costs would represent 6 % of the price, mainly monitoring costs and indicative insurance costs. In non-intensive maize production (organic or conventional) costs would represent 4 % - 5 % of the price. In the organic farm, high product prices reduce the economic effect on the total costs, despite rather high indicative insurance costs.

39. Potato is the less affected model crop. There is no need to change agricultural practices for any of the farms and a very high yield as compared to oilseed rape and maize further decreases the costs per tonne. Monitoring and indicative insurance costs would amount to 1 % - 3 % of the farm gate price.

40. In general organic farms have higher costs per hectare and per tonne compared to conventional farms. This is caused by slightly higher monitoring costs and higher indicative insurance costs as well as, in some cases, higher costs for changing farming practices. However, when relating costs to product prices, the price premia for organic crops reduces this difference considerably.

Future research needs

41. Some of the recommended farming practices could also be employed by farmers growing GM crops. Further studies will be needed to identify and evaluate the effectiveness of practices that these farmers could specifically use to minimise probability of adventitious presence of GM crops in non-GM crops. This could include also specific biological characteristics of GM crops for containment of transgenes.

42. More information on actual levels of seed impurities in the lots marketed in the EU (which is becoming available from some Member States laboratories) is essential for simulations like the ones presented here. Also, a study similar to the one described here for OSR seed could be useful for maize seed, to better understand how co-existence will impact on seed production and to provide information for an adaptation of seed production standards.

43. An exhaustive laboratory survey of the actual presence of traces of GM crops in non-GM crops (in countries where GM crops are widespread) is lacking.

44. For a more comprehensive analysis of economical impacts of co-existence a deeper analysis concentrating on the complete economic environment of a farm could be envisaged.

Annex to Summary

Table A: Levels of adventitious presence of GM OSR in non-GM oilseed rape seed production in conventional and organic agriculture with current and with recommended farming practices (50% GMOs in the region, medium-term evaluation)*

	Certified hybrid seed production		**Farm-saved seed production**	
Farm type	**Conventional**	**Organic**	**Conventional** (50% GMOs also grown on the farm)	**Organic**
Farm characteristics Farm area Plot size Number of (seed) plots	 131 ha 6 ha 1-2	 131 ha 6 ha 1-2	 351 ha 11 ha 6-7	 351 ha 11 ha 6-7
Current practices Total rate of adventitious presence expected	0.42%	0.61%	0.59%	1.05%
Best change of practices To meet threshold 0.3%	To introduce a spring crop in the rotation	Spring sown set-aside***	Dedicated machinery, cleaning machinery	Spring sown set-aside
Total rate of adventitious presence expected	0.19%	0.04%	0.23%	0.11%
Additional Costs (€ / ha)	~0**	194.3	93.2	194.3
Best change of practices To meet threshold 0.1%	Spring sown set-aside	Spring sown set-aside	Not achievable	Combination of pratices****
Total rate of adventitious presence expected	0,03%	0,04%		0.07%
Additional Costs (€ / ha)	194.3	194.3		198.6

* The seed bank is assumed to be pure at the beginning of the simulations

** No additional costs compared to current practices

*** Advancing GM OSR sowing date is also an effective measure, but depends on favourable weather conditions and thus is not reliable enough.

**** Combination of practices includes difference in sowing time, chisel before other crops than rape, spring sown set-aside and region-wide border management

Table B: Levels of adventitious presence of GM maize in non-GM grain maize production in conventional and organic agriculture with current and with recommended farming practices (50% GMOs in the region)

	Intensive maize cultivation area				**Non-intensive maize cultivation area**		
Farm type	**Conventional France** (50% of GMOs in and outside the farm)	**Organic large**	**Organic small**	**Conventional Italy** (50% of GMOs in and outside the farm)	**Conventional** (50% of GMOs in and outside the farm)	**Organic large**	**Organic small**
Farm Characteristics							
Farm area	60 ha	60 ha	10 ha	50 ha	100 ha	100 ha	15 ha
Plot size	3-4 ha	3-4 ha	1 ha	8 ha	20 ha	20 ha	3 ha
Number of plots	14	14	1	3	1	1	1
Current practices Total rate of adventitious presence expected	2.25 % (+/-0.6%)	0.16 % (+/-0.07%)	0.58 % (+/-0.04%)	1.75 % (+/-0.2%)	0.8 % (+/-0.5%)	0.17 % (+/-0.09%)	0.32 % (+/-0.04%)
Best change of practices to meet threshold 1%	50 days difference in flowering time + post-harvest management	Current practices	Current practices	Minimum distance 200m + post-harvest management	Post-harvest management	Current practices	Current practices
Total rate of adventitious presence expected	0.66 % (+/-0.3%)*			0.69 % (+/-0.3%)*	0.51 % (+/-0.3%)*		
Additional costs (€ / ha)	45.4 + n. d.	0	0	n. d.	n. d.	0	0
Threshold 0.1%	Not achievable						

* It is assumed that the percentage of seed impurities is 0-0.3%. For homozygous GM maize varieties, the effect of seed impurities in the produced crop is doubled. Therefore it is assumed that the effect of the seed impurity is in the interval of 0 – 0.6%, here expressed as 0.3 +/- 0.3%.

n.d. not determined

Table C: Levels of adventitious presence of GM potatoes in non-GM potato production in conventional and organic agriculture with current farming practices (25 to 50 GMOs in the region)

	Potatoes for direct consumption and processing		**Early potatoes**	
Farm type	**Conventional** (25 to 50% of GMOs also grown on the farm)	**Organic**	**Conventional** (25 to 50% of GMOs also grown on the farm)	**Organic**
Farm Characteristics Farm area Plot size Number of plots	 150 ha 10 ha 3	 150 ha 10 ha 3	 75 ha 3 ha 5	 75 ha 3 ha 5
Current practices Total rate of adventitious pesence expected	0.36 % (+/-0.15%)	0.1 % (+/-0.02%)	0.54 % (+/-0.21%)	0.16 % (+/-0.05%)
Best change of practices to meet threshold 1%	Current practices	Current practices	Current practices	Current practices
Additional costs (€ / ha)	0	0	0	0
Threshold 0.1%	Not achievable			

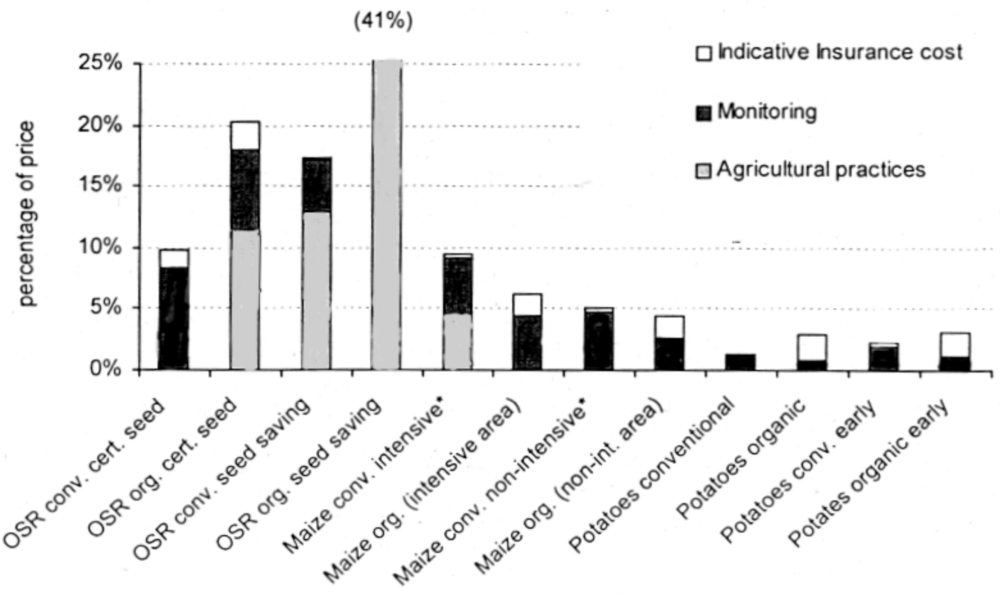

Figure A: Total costs of achieving thresholds for adventitious presence of GM crops in non-GM crops as percentage of farm gate price (targeted threshold 0.3% for oilseed rape, and 1% for maize and potatoes)
* For conventional maize, costs for changes in the post-harvest management are not included.

CONCLUSIONS

Consumers, food/feed industry and retailers demand a reasonable degree of choice between GMO- and non-GMO-derived products. But different modes of agricultural production are not naturally compartmentalised. If GM crops increase their share in EU agriculture (which is now minimal) questions arise concerning their possible co-existence with non-GM crops (conventional and organic) at farm level or regional level. Some of these questions are of agronomic and economic nature, and these are addressed in this report:

- *What will be the levels of adventitious presence of GM crops in organic or conventional crops, with current farming practices if the share of GM crops increases to 10% or 50%?*

The study was done for three crops for which GM varieties are available (oilseed rape for seed production, maize for feed production and potatoes for consumption), and for several farm types (both organic and conventional) that were defined to cover the variability present in EU farming infrastructure. For all crop-farm combinations, a hypothetical share of GM crops of 10 % or 50 % in the region was considered. A share of 50 % mimics the situation in countries that adopted GM crops readily (for example the share of GM oilseed rape in Canada is currently 54 %), while the 10 % figure represents a scenario of slow adoption of GM crops in the EU.

In these scenarios, an estimation of the expected levels of adventitious presence of GM crops in non-GM crops was done with a combination of computer modelling and expert opinion. The estimations have a strong relative value (i.e. they are useful in predicting the effect of a change in farming practices) but the absolute figures obtained have to be taken with care since the models are not yet fully adjusted with field data.

The estimated levels of adventitious presence of GM crops do not change dramatically between the two scenarios of GM crop share (10 % or 50 %). A practical consequence is that measures to prevent adventitious presence of GM crops (see below) may have to be implemented in the early stages of adoption.

On the other hand, the estimated levels of adventitious presence of GM crops in non-GM crops - assuming current farming practices - vary significantly depending on the crop and farm type (for example, as much as 2,2 % for a conventional intensive maize farm or as low as 0,1 % for an organic potato farm). In general there is a trend to expect lower levels of adventitious presence of GM crops on organic farms, because of segregation systems already in place, but there are notable exceptions. For example in seed production of rape, organic farms will face higher probability of adventitious presence of GM crops due to problems in controlling volunteers with organic practices.

Sources of adventitious presence of GM crops are well known, and can be divided into four main origins (seed impurities, cross-pollination, volunteers and harvesting-storage practices). The relative importance of each source for the final level depends on the crop and farm type: volunteers are a key source of adventitious presence of GM crops for rape seed farms (especially organic) but are of low importance in maize farms, where seed impurities and cross-pollination account for most of the adventitious presence of GM maize.

- *Can this adventitious presence of GM crops in organic or conventional crops be reduced below certain policy-relevant thresholds with changed farming practices?*

Once again the answer depends on the farm-crop combination. The thresholds used in the analysis are similar to those being discussed in various regulations. These are 0,3 % for seed production of allogamous species (rape) and 1 % for maize and potato crops (for food-feed uses). All farm types producing oilseed rape seed or conventional maize will need significant changes to meet their thresholds. In some cases (dependent on farm type) changing farming practices at the individual farm level will be insufficient. In these cases changes may involve co-operation between neighbouring farms. Examples are the introduction of sowing date differences between GM and non-GM varieties, or region-wide border management. In contrast, all potato farm types and some maize farm types (organic) could meet these thresholds with current farming practices (with all the reservations already mentioned for the value of absolute figures).

- *Can adventitious presence of GM crops in organic or conventional crops be avoided?*

The possibility of changing practices to meet very low thresholds for all crops, near the analytical limit of quantification (~ 0,1 %) is also considered in the report. This reflects the situation in organic farming where the use of GM varieties is not permitted (Council Regulation (EC) 1804/1999), setting a *de facto* threshold. The report concludes that a 0,1 % limit will be extremely difficult to meet for any farm-crop combination in the scenarios considered (10 % and 50 % GMOs in the region), even with significant changes in farming practices. Perhaps some farm types producing seed of oilseed rape could approach such thresholds, but only with significant changes of farming practices.

- *What is the cost of these changes?*

Compliance with the 1 % and 0,3 % thresholds through changes in farming practices and introduction of a monitoring system as well as likely insurance needs may result in additional costs of 1 % - 10 % of current product price for the farm-crop combinations studied (in the 50 % scenario). Exceptions are found in the production of seed of oilseed rape, where costs can be much higher in particular farm types (up to 41 %). In all cases, monitoring activities account for a large part of the additional costs. Cost reductions might be possible with segregation becoming an integrated part of agricultural practices and with decreasing costs of GMO tests. Generally, organic farms face higher costs (especially indicative insurance costs) per hectare and per tonne than conventional farms. However, when relating costs to product prices, the price premium for organic crops may reduce this difference considerably.

- *Can the different types of production co-exist in a region?*

This question has to be examined case-by-case for each crop. However, it seems clear that co-existence with thresholds in the region of 0,1 % is virtually impossible in any of the scenarios considered. When considering the 0,3 % (production of seed) and 1 % (food-feed production) thresholds, co-existence of GM and non-GM crops in a region (with 10 % or 50 % GMO share) might technically be possible but economically difficult because of the costs and complexities of changes associated. This is the case exemplified by seed production of rape. For potato the costs are much lower and no significant change of practices is needed, so co-existence could be a reality. The costs and types of adaptation of maize growers put this crop in an intermediate situation, but some types of conventional, intensive maize farms will have difficulties in a co-existence situation.

- *Can the different types of production co-exist on the same farm?*

Finally, cultivation of GM and conventional or organic crops on the same farm might be an unrealistic scenario, even for larger farms. Due to the importance of volunteers, oilseed rape seed producers will exclude growing GM crops on the same farm to avoid adventitious presence of GM seeds in their non-GM seeds. Also for maize and potatoes it would make the handling of the crops rather difficult.