March 2004

Briefing

GM Contamination

How to prevent GM contamination of the food chain and countryside.

Introduction

This briefing describes the minimum measures that would be necessary to ensure that food chains, crops and the countryside remained free of GM contamination if the Government were ever to grant commercial approval for a genetically modified (GM) crop to be cultivated or imported into the UK. It reviews the research on how contamination occurs and suggests minimum requirements that would need to be in place before the existing non-GM food chains could operate without a constant worry of GM contamination. It suggests in the absence of a completely clean bill of health from the Government's GM-Science Review[1] that the acceptable threshold for GM contamination should follow the precautionary approach. This briefing only examines cross pollination and contamination in crops that were grown in the Farm Scale Evaluations (FSE).

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What does GM-free mean?

The overwhelming majority of European consumers strongly support a right to choose food that does not contain any GM ingredients[2]. This right was recognised by EU Member States and MEPs when they agreed to pass legislation to ensure that the GM content of human food and animal feed was clearly labelled and that labelling should be verifiable by a clear traceability system[3]. Unfortunately, heavy lobbying by industry led to the setting of a threshold of 0.9 per cent contamination for each ingredient before labelling is required. This threshold was not based on any scientific considerations of human and animal health or environmental protection. The uncertainties that surround the impact of genetically modified organism (GMO) releases were set out in the GM Science Review Reports[4]; areas of uncertainty highlighted included identification of potential allergens and the extent to which cross pollination would take place following the widespread growing of GM crops.

GMO legislation is based on the precautionary approach. However, in the case of the Traceability and Labelling Regulations this seems to have been abandoned in favour of political pragmatism. Friends of the Earth believes that in the light of scientific uncertainty about the long term impact of GM crops and food, the lowest possible threshold should be adopted. At present we believe that this is 'not detectable' at 0.1 per cent. This is the threshold used by the Government's own Central Science Laboratory and is reliable and verifiable.

Organic growers and many food manufacturers work to the 0.1 per cent threshold at present. Adopting this as a legal requirement for the UK's food and agricultural industries would be in line with the precautionary principle and public opinion as expressed during *GM nation?*[5] and other projects to gauge public opinion.[6] [7]

How and where GM contamination can occur

GM contamination can occur at any stage along the food chain as a result of natural processes and human intervention: from seed production, to crop growing, to harvesting, to storage, to transport, to processing and packaging. Legally binding measures to prevent contamination would need to be in place at every stage.

Cross pollination between neighbouring crops is likely to be a common way for contamination to occur. The extent to which this occurs varies between species (see later) and pollen can either be wind- or insect-borne. Feral (wild crop plants), volunteer (weed crop plants in following crops produced from seeds dropped during harvesting) and wild plants related to the crop could all be sources of GM contamination via cross pollination. GM volunteer plants growing in a following crop of the same species can cause contamination if they are not controlled. How long seeds remain viable in the soil varies from species to species.

Physical movement of GM seeds can also occur in farm equipment such as drills, harvesters and trailers. Seeds can be moved in the equipment or on tyres, and even on clothing and footwear. Leakages and spillage of seeds can take place almost anywhere from field to factory. Animals and birds could also move seeds from store and field to where germination could occur in following years. Farm operations can cause the adventitious mixing of conventional and GM seeds, for instance, if remnant GM seed remains in drills, harvesters, trailers, silos and augers. Similar contamination can occur during road transport and processing in lorries and stores previously used to contain GM crops or seeds. Imported GM crops intended for the food or feed chain can also be spilt between ship and processing factory and result in GM plants growing along transport routes.

GM volunteer plants can occur in following crops for many years after a GM crop in some species causing contamination of following non-GM crops.

Biotechnology companies should have responsibility for ensuring that contamination does not occur and should be strictly liable for any harm arising from contamination of the crops or the environment. Given there are a number of gaps and uncertainties surrounding the safety of GM crops for health and the environment acknowledged by the GM Science Reviews in 2003[8] and 2004[9], a precautionary approach dictates that the contamination threshold should be as low as possible: 'not detectable' at 0.1 per cent.

Preventing contamination – factors to be considered

A report published by the European Environment Agency[10] in 2002 highlighted the difficulties in preventing GM contamination. This report assessed the frequency of gene flow from outcrossing. Their assessment for the three crops cultivated in the FSE in the UK is as follows

Crop	Frequency of gene flow crop to crop	Frequency of gene flow to wild relatives
Oilseed rape	High	High
Sugar beet	Medium to high	Medium to high
Maize	Medium to high	No wild relatives

The information required to set separation distances that ensure that no detectable GM contamination occurs comes from the study of pollen movement by wind and insects. Plants produce far more pollen than they actually need to fertilise the limited number of ova (female germ cells) that plants produce because pollination is a random process. For example, a single maize plant can produce up to 50 million pollen grains[11]. Extremely long distance transport of pollen by wind and insects has been recorded, for example tree pollen has been detected on treeless Shetland, 250 km from the nearest mainland[12].

Pollen movement is influenced by wind speed, air turbulence, topography, plant species, pollen size and local vegetation. Whether or not pollen will fertilise receiving female ova will depend largely on the time elapsed since the pollen was shed by the male anthers, and the weather. The viability of pollen decreases with age and the rate of decline will vary with temperature and humidity. The size of pollen sources is an important factor in estimating how much and how far pollen will move from the crop.

Research has shown that the majority of pollen falls close to its plant of origin. So the total amount of airborne pollen declines rapidly within metres of the crop; but because of the huge excess of pollen produced, significant numbers of grains remain airborne for much longer producing a long tail of pollen stretching downwind of the crop. This type of decline is termed leptokertic. One reason why pollen grains fall to the ground close to the plant is that grains can stick together and are therefore heavier. There are three basic components of pollen movement in the air:

- Gravity component which causes pollen grains to fall out rapidly close to their parent plant
- Local pollen, which is caused by wind; the amount of pollen in the plume declines rapidly downwind as grains are scavenged by ground cover.
- Regional pollen, in which pollen can travel considerable distances downwind because of grains being lifted by convection cells, turbulence and updraughts.

Insects, particularly bees and butterflies, visit crop plants to collect nectar and pollen from flowers and can transport pollen between crops over considerable distances. Some visit flowers to lay eggs and can cause considerable damage to flowers, and hence yield, as well as moving pollen between crops. For instance the pollen beetle (*Melegethes* spp) is a major pest of oilseed rape.

Crop separation distance current practice

In 1998 the industry body established to oversee the commercialisation of GM crops in the UK, the Supply Chain Initiative on Modified Agricultural Crops (SCIMAC), issued a code of practice designed to limit the transfer of GM traits to neighbouring crops of the same species[13]. The following separation distances were proposed and used during the Farm Scale Evaluations in the UK

Crop type	Certified seed crops (same species)	Registered organic crops (same species)	Non-GM crops (same species)
Oilseed rape	200m	200m	50m
Sugar and Fodder beet	600m	600m	6m
Forage maize	200m	200m	200m sweet corn 50m forage maize

The separation distance for forage maize was increased by Defra during the FSE to 80m, and this is the current distance stipulated by Defra for National List Trials of GM maize seed varieties. The shorter distance for fodder maize reflects that fact that the whole crop is harvested and used rather than just the cobs. The SCIMAC code is not designed to ensure that there is no GM pollen detectable in honey.

The SCIMAC separation distances are largely built around existing practice in producing accredited seed for sale to farmers around the world. In addition, two models in the UK are used to demonstrate the effectiveness of these separation distances – the production of oilseed rape with high Erucic Acid levels (HEAR) for industrial usage and the Essex Seed Zoning Scheme. The applicability of the current practices in the seed industry depends very much on the level of purity currently accepted for certified seeds. Certified seeds are required to meet legal levels of varietal purity set out in various European Union directives on seeds. Separation distances have been stipulated by the EU, the Organisation of Economic Co-operation and Development (OECD) and the UK to meet thresholds for seed purity. These need to be compared to the distances found in scientific research at which cross pollination has occurred and recommendations from the EU's Scientific Committee on Plants.

Separation Distances and Times

Beet and Sugar Beet

Separation distances for beet seed production vary from 1000 metres for basic seed (first generation) to 300-1000 metres for certified seeds (seeds produced to sell to farmers). The distances vary depending on the genetics of the parents. These distances are set down in the Beet Seed Regulations.

Beet pollen has been shown to travel considerable distance beyond 1000 metres. Sugar beet and fodder beet are able to cross-breed with other crops, including beetroot and spinach beets, as well as with wild sea beet (*Beta vulgaris ssp maritima*). Beet is pollinated by wind and by insects. Beet crops are biennial, but there can be flowering in the first year, known as bolting, in a minority of plants. The pollen of sugar beet and fodder beet can travel at least three kilometres[14] so cross pollination between bolting plants in different fields is a possibility. In wild beet populations in the UK gene flow occurring between populations at a distance of 14 km has been recorded[15].

In a memorandum to the European Commission on the adventitious presence of GM in seeds, the Scientific Committee on Plants[16] recommended that to produce seeds below a threshold of 0.5 per cent the separation distance should be 2000 metres (twice the current distances recommended for conventional varietal seed purity). Thus to achieve a threshold of not detectable at 0.1 per cent a minimum separation distance of 4000 metres will be required.

An additional problem associated with GM beet crops is the potential to produce GM weed beet. To ensure that this does not occur bolting GM beet would have to be destroyed before it flowered. Typically bolting occurs in less than one per cent of the crop[17]. The current methods of dealing with bolting beet crops are hand pulling and dragging a RoundUp impregnated wick behind a tractor. As the GM beets grown in the FSE were tolerant to Monsanto's RoundUp (glyphosate) the latter method would not be viable and farmers would have to resort to labour intensive hand pulling. If beet is not harvested effectively, roots can remain in the field and could flower in the following crop or in field margins if not destroyed by the ground preparation for the following crop.

A 1991 survey found that only two thirds of sugar beet farmers controlled bolters in the UK[18]. It seems highly likely that GM beet plants will bolt and flower in locations around the country leading to cross pollination with weed beet and potentially sea beet. The EC Scientific Committee on Plants highlighted the need to control weed development in the context of beet seed production: "Control of weed beet will be paramount to minimise potential for transgene flow"[19] Weed beet is reported to be found in two thirds of fields and "infestations are getting worse"[20]. Beet seed can remain dormant in the soil for many years and the Scientific Committee on Plants stated that it has "long persistence"[21]

Recent research in France has shown the capacity for humans to inadvertently move transgenic beet seed in soil on farm vehicle wheels. Beet transgenes were found in weed beet 1.5 km from the GM crop and the researchers concluded "If GMO sugar beets are established in regions where populations of the wild form also occur, then gene flow between wild and cultivated relatives is almost inevitable"[22]

Maintaining beet seed purity alongside GM seed production and crop cultivation will be increasingly difficult without complete geographical isolation. Beet outcrosses readily and the transgression of GM traits into wild beet seems highly probable unless penalties for allowing bolters to pollinate are very severe and each field and following crop are monitored and controlled. Beet seed is produced outside the UK and every imported seed lot should be routinely sampled before being allowed into the UK. EC proposals for GM threshold seed purity [23] allow for a 0.5 per cent GM contamination rate with an approved GM variety (the proposed threshold for unapproved varieties is zero) before seed would require a label indicating GM presence. The Statutory Nature Conservation Agencies for the UK described these tolerance levels as "unacceptable" and attacked them as "not having been derived from the needs of environmental protection, and could undermine the effectiveness of the regulatory system in preventing undesirable gene flow"[24]. They added that thresholds should be "near zero".

Oilseed rape

The separation distances used for oilseed rape seed production in the UK and internationally range from 100 metres to 500 metres. The longer distances are for first generation (basic) hybrid seeds. The separation distances for non-hybrids range between 100 metres and 200 metres. Based on these distances, seed purity of 99 to 99.7 per cent is said to be achieved for non-hybrid certified seeds. For hybrid seeds (500 metres separation) basic seed purity is said to be 98-99 per cent, and for certified seeds (300 metre separation) purity is 90 per cent. The current list of Recommended Varieties from NIAB[25] consists of six conventional varieties and five hybrids. The equivalent Home Grown Cereals Authority list contains six conventional varieties, five hybrids and six varietal associations (see later).

Oilseed rape seed production takes place in the UK but considerable amounts are imported. All imported seed lots would need to be monitored for GM content before entering the country. A considerable amount is also farm saved. Data on the location of farms saving their own seed are sketchy. Estimates for the percentage of seed farm saved vary between 15 and 40 per cent[26]. As farm saved seed is likely to continue in arable farming as a legitimate way to cut costs then the lack of information on the location of fields will cause serious difficulties in any coexistence regime.

When reviewing seed purity and the adventitious presence of GM, the EC's Scientific Committee on Plants[27] recommended the seed production separation distance for hybrid oilseed rape increase by a factor of ten to 5000 metres for basic seed and 3000 metres for certified seed to meet a threshold of 0.3 per cent GM contamination. Some oilseed rape commercial varieties known as varietal associations increase the complexity of managing cross pollination in oilseed rape crops because 80 per cent of the plants do not produce pollen and therefore depend on cross pollination from other plants to set seed. These varieties comprise of around five per cent of the market [28](one in twenty fields) with the majority being grown in Scotland.

Recent research on cross pollination in oilseed rape supports the view that widespread commercial growing of GM oilseed rape will make coexistence difficult, concluding "if transgenic oilseed rape is grown on a large scale in the UK, then gene flow will occur between fields, farms and across landscapes"[29]. It also highlighted the lack of reliable data on cross pollination in oilseed rape and related species.

"Gene flow at this level should be investigated on a landscape scale using larger numbers of transgenic pollen sources, and examining different genotypes (both of the transgenic plants and conventional varieties), the extent of pollen flow at further distances from sources, a range of environmental conditions, geographical location and patterns of cropping of GM and non-GM crops. It is only when these studies have been concluded under a range of UK conditions that farmers and seed producers will be able to accurately predict outcrossing levels and develop appropriate strategies for managing it"

Other key information emerging from the research includes:

- Seed spillages and failures to clean combine harvesters are likely to be a significant source of GM contamination.
- One volunteer GM plant per square metre in a field of oilseed would produce contamination rates of between 0.6 and 1.5 per cent depending on variety.
- The discovery of weedy populations of wild turnip co-existing and hybridising with oilseed rape in England. One plant sampled had 81 GM seeds out of 167 (48.5 per cent).
- 0.5 per cent contamination rates in crops at distances up to 200m. 3.2 per cent contamination rates at 105m in some oilseed rape varieties.
- GM oilseed rape volunteers (weeds in following crops) survived for at least four years (up until the research was terminated in 2000).
- Wild oilseed rape close by crop fields was also contaminated.

The report recommends more research into the hybridisation of oilseed rape. Other reviews conclude that oilseed rape pollen can cross pollinate at considerable distances from the source. The scale of oilseed rape large scale production is likely to be an important factor in the levels of cross pollination. Feral plants and wild relatives are also likely to cross pollinate with GM crops, adding to the complexity of gene transfer. The research shows the potential for wild turnip (*Brassica napus*) to hybridise with oilseed rape (see above) and other relatives have been shown to exhibit some ability to cross pollinate. The wild relatives with which oilseed is likely to hybridise with in the field are wild turnip (*Brassica rapus*), hoary mustard (*Hirschfeldia incana*), wild radish (*Raphanus raphanistrum),* white mustard (*Sinapsis arvensis*) and wild cabbage (*Brasssica oleracaea)*. This is an area where it is acknowledged that further research is required, eg "more data needs to be obtained on the spontaneous hybridisation between *B. napus* and *R. raphanistrum* under natural field conditions"[30]

Research published in 2003 [31] estimated the likely annual hybridisation rate for *Brassica napus* in the UK. Estimates show that around 32,000 hybrids appear annually in wild riverside populations and some 17,000 arise in weed populations across the UK, which are mainly confined to Humberside at present.

Supporters of the SCIMAC code point to the success of the scheme for growing high erucic acid oilseed rape (HEAR) (this crop is destined for industrial usage and elevated levels of erucic acid in food and feed would be toxic) and the Essex Seed Zoning Scheme. Neither scheme provides convincing evidence that the SCIMAC separation distance and protocols will prove successful in limiting cross pollination for oilseed rape.

In a report prepared for the National Institute of Agricultural Botany (NIAB)[32] in 2000, an assessment of the HEAR schemes was given:

"HEAR crops are subject to separation distance requirements from other crops of 50m. The EU limit for the level of erucic acid in low erucic acid crops is 2 per cent (Bilsborrow et al 1998). Low erucic varieties contain close to 0 per cent erucic acid and the high ones are usually about 50 per cent. The heterozygote produced by crossing does not fully express the erucic acid content of a homozygous individual. Consequently crossing has to have been at more than 4 per cent before a crop would fail the 2 per cent limit. The level of checking on the produce is low and for these two reasons the field experience of this scheme is not a sensitive test of the limits to be considered in this report".

In other words, thresholds are more than double the thresholds proposed for GM content in food and feed and at least six times that proposed for oilseed rape certified seed (0.3 per cent).

The Essex Seed Zoning Scheme was set up during 1939 to protect seed crops of *Brassica* species (which includes oilseed rape), beet species and *Allium* species (onion family) from undesirable foreign pollen in the northern half of Essex, which had a long tradition of growing seed crops of these species.

In recent years the number of seed crops being grown in the area has been declining. Earlier this year the last remaining grower of vegetable *Brassica* seed crops announced his intention to cease seed growing in the UK. Generally the scheme was used to protect high value vegetable seed crops, although recently oilseed rape seed crops have been included, including HEAR crops. The scheme is administered locally on a voluntary basis, but disputes about separation distances can be settled by the Minister under Section 33 of the Plant Varieties and Seeds Act 1964. The areas covered by the scheme lie to the north of Chelmsford and the Blackwater estuary. In 2002 only seven seed crops covering 43 hectares[33] were grown and no disputes arose.

A small number of fodder rape seed crops and kale seed crops have occasionally been grown in the protected area which afforded them protection under the scheme. The separation distances required by the Essex Scheme are greater than those required under the appropriate statutory scheme. The small scale of the scheme and the largely voluntary nature do not provide any degree of assurance that such a scheme could operate nationally in circumstances where 50 per cent or more of the oilseed rape being grown was GM.

Further evidence of the likely contamination problems for oilseed rape producers comes from Canada. At least two lots of seed imported into the UK have already been found to be contaminated. As a consequence, some non-GM oilseed rape seed production has moved elsewhere in the world. The first incident occurred in 2000, when the spring oilseed rape variety Hyola 308 was found to be contaminated to around one per cent with one or more GM varieties. Such contamination would possibly take the final crop above the EU threshold for labelling of 0.9 per cent. An investigation by the Canadian Food Inspection Agency[34] published in February 2002 was "unable to determine the source of the adventitious presence" but "found no impropriety on the part of Advanta Canada, its third party or the Canadian Seed Growers Association that would require regulatory action to be taken". However, the results of the analysis showed that 77 per cent of samples were contaminated with the Monsanto transgene GT73 for glyphosate tolerance. In the certified seed lots 14 out of 24 samples were found to exceed the proposed EU threshold for GM in oilseed rape seed and the highest contamination level was 2.8 per cent. The Canadian Food Inspection Agency report confirmed that separation distances of 800 metres were used in the production of these seed lots. In evidence to the House of Commons Agriculture Committee[35], Dr David Buckeridge of Advanta Seeds UK informed the committee that in the case of these crops, it was grown with a four kilometre separation distance: five times the Canadian regulatory separation distance for seed production. Advanta Seeds UK finally paid compensation to the several hundred UK farmers affected by the contamination who were forced to plough in their seedling crop.

The second incident involved the contamination of GM spring oilseed rape seed used in the FSE in England and Scotland. Three unapproved GM traits for antibiotic resistance were detected by unofficial sampling at the Scottish Agricultural College, and the maximum contamination rate was found to be 2.8 per cent. The Advisory Committee on Releases to the Environment and the Government's GM Inspectorate based at the Central Science Laboratory at York offered no explanation for the contamination, nor did the company which produced the seed, Bayer CropScience. This incident clearly shows the difficulties in maintaining pure seed lines in areas where GM oilseed is produced. In the end it does not matter how the contamination occurred, by cross pollination or admixture before sowing or after harvest, the impact is the same: farmers will be forced to label their non-GM crops as containing GM and potentially lose their premium market or even be unable to sell the crop at all. In the long run the environment may also suffer.

The potential for seed contamination to spread GM traits into volunteer and feral oilseed populations and wild relatives was highlighted by Statutory Nature Conservation Agencies in their comments on the EC proposals for the adventitious presence of GM traits in seeds[36]. For oilseed rape they calculate that the proposed threshold of 0.3 per cent GM presence would result in "up to 10,000 GM seeds per hectare" being "inadvertently sown". They point out that this could lead to the stacking of genes in individual volunteers, leading farmers "to resort to older, more environmentally damaging herbicides such as 2,4D to control volunteers with stacked HT [herbicide tolerant] transgenes". The phenomenon was reported in the western Canadian region[37] relatively soon after commercial growing commenced. The EC proposals assume further cross pollination of the crop sown from contaminated seeds. The SCIMAC code of practice and separation distances[38] do not consider these issues. The code concedes that cross pollination is possible and recommends that farmers "control any volunteers with cultivations, an alternative selective herbicide or as a mixture with the selective herbicide". Thus, the often stated benefit that GM herbicide tolerant crops will reduce pesticide usage is open to question if contamination is allowed to take place on the scale which seems likely if SCIMAC's separation distances are adopted.

During growing and harvesting operations large amounts of oilseed rape seed can be shed on to the soil when seed pods shatter (up to 5 per cent of the crop[39]). The longevity of oilseed rape seed in the soil depends to some extent on how the field is managed directly after harvest to avoid incorporating the spilt seed into the soil. The EC Scientific Committee on Plants reported that volunteers could arise from spilt seeds "for up to 10 years, possibly longer"[40]. Defra sponsored research on the impact of GM oilseed rape on crop purity suggested that some oilseed rape could survive for up to 16 years[41]. Modelling work in the same report highlighted the need to prevent GM volunteers producing seeds. It predicted that non-GM oilseed rape could be contaminated for at least 16 years if GM volunteers were not controlled, with impurity in yield not declining to 0.9 per cent until year 16.

The extent to which insects contribute to cross pollination in oilseed rape is still unclear. Oilseed rape pollen is extremely attractive to bees, and honey bees travel several miles to collect pollen. During the FSE the British Beekeepers Association recommended that beehives should be sited at least six miles from the nearest GM trial field. Bees at an FSE pilot trial in Oxfordshire were found by Friends of the Earth's consultants to have travelled 4.5 km to the plot to collect pollen. GM pollen has been detected in honey produced in the UK by Friends of the Earth in England and the Sunday Times in Scotland. The image of honey as a pure and wholesome food could be seriously damaged if GM pollen content had to be labelled. If GM oilseed rape was widespread, maintaining the GM free status of honey would be very difficult and many beekeepers (commercial and hobby) could be forced to give up. This could have repercussions for farmers who rely on honey bees for their vital pollination role each spring. The value of this service to UK farmers and growers was over £172 million for outdoor crops and over £29 million for glasshouse crops in 1996[42]. The extent to which bees and other insects contribute to moving pollen over considerable distances is unclear. Recent research published by Defra found cross pollination of male sterile bait plants occurred at 26 km and the researcher suggested that pollen beetles may have been responsible for this very long distance movement[43].

From the available scientific data and the work of the EC Scientific Committee on Plants the minimum separation distance for GM oilseed rape crops should be 10 km if no GM presence is to be detected in non-GM seed crops, food/feed crops and in honey. Strict adherence to time separation rules between GM and non GM crops will be required to prevent gene flow from volunteer plants. Constant monitoring and control measures will be required to prevent gene flow into feral oilseed rape and wild relatives which could act as a source of GM pollen to cause contamination of crops.

Maize

The separation distance required for maize seed production set by the OECD, EU and UK is 200m. This is designed to limit contamination to between 0.1 and 1.0 per cent, depending on the approach used in breeding the variety. For open pollinated varieties, which would be the situation if commercial maize was grown in the UK, the threshold is 0.5 to 1.0 per cent. Two hundred metres is the SCIMAC code separation distance for seed production, sweetcorn and organic production. The distance for fodder maize growing currently being used is a mere 80 metres (the original SCIMAC distance was 50 metres) remembering that this is based on the whole crop not just cobs.

Maize produces distinct male and female flowers, known as "tassels" and "silks" respectively. Most pollination events are due to airborne and windborne pollen from other plants[44] and only one in 20 are self pollination. Maize produces large amounts of pollen. Honey bees and other insects do not generally assist with cross pollination in maize but bees will utilise maize pollen as a source of food, so the potential exists for honey to be contaminated with GM maize pollen[45].

The UK does not produce maize seed because of our climate. Maize growing is mainly for fodder which is made into silage and fed to cattle. Some sweetcorn is produced commercially, and it is a common amateur crop on vegetable plots and allotments. Most maize is grown in the south and west of the UK as the crop requires milder weather to reach maturity.

Scientific papers indicate that there is good evidence to suggest that maize pollen cross pollinates over much greater distances than 200 metres. Despite rapid deposition of pollen close to the source plant, the huge amounts produced (up to 25 million pollen grains per plant) result in significant amounts being airborne (125,000 grains) even when concentrations have dropped by 99.5 per cent at 500 metres[46].

Contamination of maize seed lots with GM traits has already occurred in France where levels are reported to be over one per cent[47]

Maize pollen is heavy compared with that of other wind pollinated species. However, scientific research is limited to distances of 800 metres from the crop and to a height of 4.6 metres above the ground[48]. The percentage of hybrid kernels in maize cobs at various distances from the source of pollen has been looked at by several researchers. This is relatively easy to do in maize because there varieties that produce distinctively shaped or coloured kernels (black, blue and yellow for instance). Outcrossing of 0.21 per cent at a distance of 800 metres has detected[49]. At 200 metres, these studies found average cross pollination rates of 1.6 per cent and 0.5 per cent with a maximum of 2.47 per cent recorded in an individual sample. The same study found a rate of 6.1 per cent at 75 metres[50].

Recent research findings published by Defra [51] confirm that cross pollination can occur at levels above 0.1 per cent beyond 200 metres from the source of the pollen. A level of 0.14 per cent was detected at 650 metres. This is entirely consistent with the previous research findings and with anecdotal reports from the USA.[52] [53]

From published research Professor Jean Emberlin of the National Pollen Research Unit stated in her evidence to the ChardonLL hearing in 2000 that:

"The available data indicates that 200m is unlikely to be a satisfactory separation distance if 0.1 per cent, or even 1 per cent, are the maximum levels of acceptable contamination.[54]"

As maize does not survive the winter in the UK there are no issues relating to contamination via volunteers. This also applies to wild relatives because there are none in the UK.

Based on the available evidence the SCIMAC separation distance for maize will not prevent contamination above 0.1 per cent. The evidence suggests that a minimum separation distance of 2000 metres between maize crops would be required to ensure that no GM presence could be detected in the non-GM crop.

Conclusions

The state of knowledge on the potential for GM crops to contaminate other crops was admirably summed up in the first report of the GM Science Review[55] :

"*Cross pollination falls off rapidly with distance but the distance at which it is zero is impossible to determine with accuracy*." (page 217).

And on the potential to cross pollinate with wild relatives:

"*Although there are uncertainties about the scale and variability of crop to wild relatives (and indeed crop to crop) gene flow, the major gaps are in the understanding the potential* *consequences of gene flow.*" (page 223).

The food industry in the UK and the rest of the EU is seeking ingredients that do not contain detectable GM traits. The widely accepted reliable limit of detection for GM traits is 0.1 per cent. The precautionary approach to public health and environmental protection and consumer preference dictates that measures to prevent detectable GM content in any food or crop should be legally binding. The laws should apply to all stages of the supply and food chain to prevent contamination occurring. The proposed thresholds for food and feed of 0.9 per cent GM content and 0.3-0.7 per cent for seeds, below which labelling of GM content would not be required, are not based on any scientific data on health or the environment. It is important to remember that farmers and food producers will have to deal with confirmed levels of contamination in their crops or raw ingredients. Studies that produce average expected contamination levels are not helpful in such circumstances because they tend to be based on simple models that do not take into account the variables which influence pollen movement. The reality is that levels of cross pollination are incredibly variable.

The GMO Private Members Bill sets down the following separation distances and times to prevent GM contamination of crops. It also requires a high level of monitoring and controls to prevent admixing of GM and non GM crops and ingredients along the supply chain, and farmer and national measures to monitor and control GM volunteers, feral populations and crop relatives to prevent GM traits becoming established.

Separation distances

The separation distances between GM plants and other plants of the same species shall be as specified in the table below.

Species	**Separation required between GMO and basic seed production of other variety**	**Separation required between GMO and certified seed production of other variety**	**Separation required between GMO and production of other variety**	**Separation required between GMO and beehives producing honey**
Oil seed rape	10,000 metres	6,000 metres	10,000 metres	10,000 metres
Sugar beet	4000 metres	4000 metres	4000 metres	n/a
Maize/sweetcorn	n/a	n/a	2000 metres	10,000 metres

Separation times

The separation times between the planting of a GMO and the planting of another variety of the same species but a different variety shall be as specified in the table below.

Species	**Separation period required between planting of GMO and basic seed production of other variety**	**Separation period required between planting of GMO and certified seed production of other variety**	**Separation period required between planting of GMO and cropping of other variety**
Oil seed rape	10 years	7 years	10 years
Sugar beet	10 years	7 years	10 years
Maize/sweetcorn	1 year	1 year	1 year

Control periods for feral and volunteer plants

The period of time for which persons planting GMOs shall control feral and volunteer plants shall be as specified in the table below.

Species	**Control period**
Oil seed rape	10 years
Sugar Beet	10 years
Maize and sweetcorn	1 year

Friends of the Earth believes that the introduction of a technology that could have such a profound impact on other businesses, public health and the environment so as to require such measures to prevent contamination is premature. All the GM crops proposed for the UK market will outcross to neighbouring crops and, in the case of beet and oilseed rape, to wild and feral plants. The simple way to prevent such contamination would be to not approve them for the UK and keep Britain GM-free. This course of action could provide economic advantage to UK farmers in a world where they find it difficult to beat off cheap foreign food imports.

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