THE CASE FOR BANNING GM OILSEED RAPE IN WALES

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> *"I think realistically it's going to be very difficult for GM oil seed rape to coexist with non-GM on the same farm because I think you will get a gradual build up in the seed banks, you will get certain levels of out-crossing occurring and it's going to be very difficult to manage, and I think that is something which farmers will have to think about"*
>
> Dr Jeremy Sweet (then of NIAB) at *The British Association GM crops: gene flow and fitness in natural and agricultural systems GM Science Review - Open Meeting,* Monday 17 March 2003, Institute of Grassland and Environmental Research (IGER), Aberystwyth

1. Introduction

The Welsh Assembly Government (WAG) consulted the public on the coexistence of GM crops, conventional and organic crops in summer 2009. The stated aim of the WAG's proposed coexistence and liability legislation was to make the growing of GM crops as "restrictive as possible" within the current legal framework in line with the policy of keeping Wales GM-free.

The document outlines the case for banning GM oilseed rape from being grown in Wales as part of the proposed legislation because the nature of the crop makes coexistence impossible and contamination of crops and the environment inevitable. This is just one approach which WAG could adopt. The presence of GM oilseed rape in Wales (of whatever type) would be incompatible with the over-arching strategy for the Department of Rural Affairs and the Second Organic Action Plan for Wales. Other key parts of the rural economy could be damaged as could biodiversity in arable areas.

2. Oilseed Rape

Oilseed rape (*Brassica napus)* is a member of the cabbage family (*Cruciferae*) which has its centre of origin in Northern Europe. Its early relatives have been grown as a crop since the middles ages[1]. Wild relatives of oilseed rape are part of the native flora of Wales. Early forms of rape, as we know it today, were recognised in the early nineteenth century when it was used as a fodder plant. Selective breeding and crossing from the mid 1940s have eliminated harmful chemicals in the oil and meal (erucic acid and gluconsinolates) and improved yields to the point that oilseed rape has become a viable arable crop. Spring and winter sown varieties were developed and in the last 30-40 years it has become a major crop in arable rotations in the UK. In 2007, 3000 hectares were grown in Wales[2] which is a tiny fraction of the 681,000 hectares[3] grown throughout the UK. Oilseed rape is used as a break crop between cereals in arable rotations and winter oilseed rape, in particular, provides an acceptable gross margin per hectare for farmers. It is therefore likely that oilseed rape will remain an important crop for Welsh arable farmers for the foreseeable future. Although only small areas are likely to be grown, these will be confined to lowland Wales where the frequency of oilseed rape fields will be close to that found in other arable areas in the UK.

Winter oilseed rape requires more fertiliser and pesticides than spring grown. Typically the fertiliser and pesticides costs are comparable with cereals and costs comprise of 65% herbicides, 25% fungicides and 10% insecticides[4].

Certified seed for oilseed rape used in the UK is mainly sourced from UK and countries in the EU (92% of imports in 2009) including France, Germany, Denmark, The Netherlands and Ireland. The total import of oilseed rape seed was just over 1056 tonnes in 2009 and the only source outside the EU was 80 tonnes from New Zealand[5]. Thus at present none of the countries from where the UK imports seed have GM oilseed rape under commercial cultivation. Germany (40 release consents since 1992) and The Netherlands (15 release consents since 1992) have licensed GM oilseed rape field trials[6]. Since 2002, the majority of GM oilseed rape field trials in the EU have been in Sweden and of the countries from where the UK imports oilseed rape seed for planting, Germany was the only country to host a field trials during this period - in 2006 (1 release consent) and 2003 (one release consent)[7]. Thus sources of seed imports are reasonable protected from GM contamination. However, WAG would be wise to insist that all imported lots are scanned for GM presence before they are allowed to enter the country.

A significant proportion of oilseed rape seed sown in the UK comes from farm-saved seed. Farmers pay royalties to the seed companies who hold plant breeders rights over the variety they have saved. It is illegal to sell farm-saved seed to other farmers (known as brown bagging). The National Association of Agricultural Contractors (whose members provide on-farm seed cleaning services for farm-saved seeds) say that 50% of farmers used some farm-saved seed in 2009[8]. Some companies say that for oilseed rape up to 55% of seeds may be farm-saved[9].

Oilseed rape can be grown to produce food quality or industrial vegetable oil and the meal/cake arising from oil crushing is used as a high protein animal feed. Some rape oil is now being diverted into bio-diesel production and the Renewable Fuels Agency estimates[10] that the amount of production in 2009/10 will be in the order of 3700 tonnes of bio-diesel (based on a yield of 3t/ha this suggests about 1250 ha of land were used).

3. GM Oilseed Rape

A number of traits have been genetically engineered into oilseed rape (known as canola in North America). The only ones which have been approved for commercial growing are in North America, and Australia and these are as follows:

- Glyphosate tolerance Monsanto – herbicide tolerant.
- Glufosinate ammonium Bayer CropScience – herbicide tolerant.
- Altered lauric acid content (limited cultivation in the US which has now been abandoned)

GM oilseed rape with a number of other traits has also been grown experimentally in test sites in North America but to date none of these have been commercially grown. These include:

- Low linolenic acid content[11].
- Herbicide tolerance to Dicamba, imidazalinone and 2,4D.
- Pharmaceuticals.
- Drought tolerance.
- Omega 3 and omega 9 enriched oil.
- Altered fat composition.

Winter and spring oilseed rape were part of the UK's farm scale evaluations from 1999-2003 when the crops trialled were tolerant to the herbicide glufosinate ammonium.

4. The Case for Banning GM oilseed rape in Wales

4.1 Containment Impossible

One of the main reasons for banning GM oilseed rape in Wales will be that it will be impossible to prevent GM traits contaminating other crops, wild plants and the food/feed chain. There are several ways in which contamination can occur because oil seed rape has many characteristics which make its containment within the field where it is grown or in containers /transport pre and post sowing and harvesting impossible:

- Pollination is by wind and insects over considerable distances.

- Seeds are small enough to slip through very small holes in stores, transport containers and equipment.
- Seeds can be blown or carried by people (for instance in clothing or on footwear).
- Spilt seeds remain viable in the soil for many years.
- Crosses easily to wild relatives and other crops.
- Volunteer and feral plants are common.
- Co-mingling of crops post harvest in transit or in store.

4.2 Evidence on Contamination

4.2 a Pollination

Oilseed rape produces large amounts of pollen and nectar which are strongly attractive to honey bees, bumble bees and other pollinating insects. Crop yields are increased by the presence of bee hives which are commonly moved near to oilseed rape fields during flowering. Research carried out for Friends of the Earth in 1999 at a GM spring oilseed rape which was part of the Farm Scale Evaluations in Oxfordshire found that honey bees travelled 4.5km to collect pollen from the GM field. Honey sold in the area was found to contain GM pollen. The role of other insect pollinators such as moths (Lepidoptera) is uncertain.

In addition, insects are attracted to oilseed rape flowers solely to feed on pollen, for instance the pollen beetles (such as *Meligethes aeneus*). They also play a role in pollination and were put forward as the vector of a pollination event over 26km involving a male sterile oilseed rape bait plant (ie produces no pollen).

Evidence of GM cross pollination events mainly comes from the production of non-GM seed crops in North America because there is limited experience in the UK or EU. Pollination between crops has been difficult to monitor until GM oilseed came along when it became possible to identify GM traits relatively easily using polymerase chain reaction (PCR) analysis.

Three incidents of GM contamination of oilseed rape seed have taken place in the UK since 2000 and in all cases cross pollination seems to be the most likely explanation given the seed industry's requirement for a high level of varietal purity;

1. Advanta Seeds UK marketed a non-GM spring oilseed rape known as Hyola 308 which was planted by about 600 farmers on 4700 ha. GM contamination levels averaged around 1% but were as high as 2.8% in some batches. Eventually the oilseed rape crops were destroyed. The farmers involved received compensation of up to £370 per ha from Advanta Seeds UK. The Canadian Food Inspection Agency investigated the contamination incident(s). Their report stated that separation distances of 800 metres between the seed crop and the nearest crop of oilseed were kept to[12]. In Advanta's evidence to the House of Commons Agriculture Committee in 2000, the actual separation distance for the contaminated seed crops was stated as four kilometres[13] which was five times the Canadian regulatory separation distance for seed production in Canada..

2. The second incident involved the contamination of GM spring oilseed rape seed used in the Government sponsored Farm Scale Evaluations (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 have provided no explanation of how the contamination occurred. Similarly, Bayer CropScience, who provided the seeds for the FSE have failed to provide a public explanation.

3. In 2008 the Scottish Government announced that Monsanto's GT73 GM oilseed rape had been found in seed being grown on trial sites for a non-GM oilseed rape variety. The trials were immediately discontinued. Subsequently, Defra announced that a winter oilseed crop in

Somerset was similarly contaminated to a level of 0.05% GM (5 seeds in 10,000). It also spread to a neighbouring field where contamination of 0.01% (one seed in 10,000) occurred. The purpose of this planting was not revealed but the seed sown was produced by Monsanto in the US. Once again the cause of the contamination remains a mystery.

Whatever the causes of these incidents, cross pollination, admixture or a combination of both, these incidents clearly show the difficulties in maintaining pure seed lines when GM oilseed is grown and highlight the propensity for oilseed rape to cross pollinate between fields.

There is also the possibility that winter and spring crops can cross pollinate if flowering overlaps. In some seasons during the last decade this has been observed by the author when late flowering winter crops were synchronised with the early flowering spring crops (often winter plants along tramlines may be late enough flowering , after the main flowering has passed over, that they are still producing pollen when the first spring flowers appear).

The impact of contamination on farmers could be considerable as they may be forced to label their non-GM crops as containing GM and potentially lose their premium market or, if unapproved GM traits are involved, be prevented from making any sale. For a high yielding crop, losses could be as much as £1020 per hectare[14].

In the long run the environment may also suffer.

4.2.b Cross pollination distances

Pollen transfer between oilseed rape crops can take place over considerable distances either through wind or insect pollination. Separation distances to limit pollination have been proposed by some EU member states, and industry in the context of coexistence between GM and non-GM crops and examples of the wide range in distances proposed is shown in the table below. There is clearly a wide measure of disagreement between different interest groups which also indicates that there is considerable uncertainty about oilseed rape pollination distances.

	Defra separation distances 2006 consultation	**Largest separation distances so far proposed by a member state**	**Separation distances proposed by National Pollen Research Unit**	**SCIMAC distance FSE**
Oilseed rape conventional	**35**	**4000[a]**	**5000**	**50 (100)[b]**
Oilseed rape organic	**35**	**6000[a]**	**5000**	**200**

Distances in metres a- Latvia b – longer distance for varietal association varieties

As already reported above, a separation distance of 4000 metres was apparently insufficient to prevent contamination of seed crops in Canada up to 2.7%. In conventional seed production, 100% varietal purity for oilseed rape is not the goal of seed companies even for basic seed (those used to multiply up certified seed lots) and they allow for contamination rates of between 0.3% and 1.0% which for non- GM crops has proved to be satisfactory. This would not be the case for GM contamination. The separation distances used for oilseed rape seed production in the UK and internationally to achieve these levels of purity, range from 100 metres to 500 metres. 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.

During the EU process to set a GM threshold in seeds (which is unresolved to date) the EC's Scientific Committee on Plants recommended the seed production separation distance for hybrid oilseed rape to increase from 500 metres to 5000 metres for basic seed and 3000 metres for certified seed to meet a threshold of 0.3 per cent GM contamination (3 seeds in every 1000)[15].

Research by the Scottish Crop Research Institute for Defra found that GM pollen had been transferred 26 km to a male sterile bait plant[16]. The researchers suggested that the likely vector was a pollen beetle which had been observed on flowers. The same report also notes that cabbage weevils successfully pollination oilseed rape plants in controlled conditions.

Thus scientific opinion on how far GM pollen could transfer between oilseed rape crops suggests a high degree of uncertainty and very long distance gene transfer is possible whilst the picture is complicated by wild relatives and feral populations. Setting a "separation" distance at which zero or even low level contamination could be achieved will be practically impossible.

The shorter distances proposed by Defra in their consultation on coexistence in 2006 came from a modelling study using data obtained from the Farm Scale Evaluation by National Institute of Agricultural Botany (NIAB)[17]. The proposed distances assume that there will be only one GM crop per area to act as a source of contamination. It also assumes that pollen distribution will follow the classical leptokertic decline curve with very rapid decline close to the crop edge followed by a long tail where pollen densities are lower but still present at measurable levels. NIAB's brief was to use 0.9% GM contamination as their based line which follows from the European Commission's guidance of July 2003.

The modelling approach adopted by NIAB is flawed in several ways:

1. Only data on cross pollination in the non-GM half of the FSE was used and hence longer pollination distances were not even studied. The BRIGHT project[18] (which was co-sponsored by DEFRA) found that cross pollination rates of 1.8% (twice the Defra target) at 56 metres (the furthest point measured) from the GM crop (21 metres further than Defra's proposed separation distance for oilseed rape of 35 metres).

2. The assumption that there is just one source of GM pollen ignores the potential for many GM oilseed rape fields in a geographical area producing pollen simultaneously. Defra sponsored research[19] published in December 2002 on cross pollination in oilseed rape concluded that widespread commercial growing of GM oilseed rape will make coexistence difficult and concluded, *"if transgenic oilseed rape is grown on a large scale in the UK, then gene flow will occur between fields, farms and across landscapes"*. It also highlighted the lack of reliable data on cross pollination on a landscape scale:

"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".

The NIAB modeling report used by DEFRA acknowledges its limitations:

It is important to be aware that this report ONLY deals with adventitious presence of GM due to transfer of pollen from a single neighbouring field. It specifically does NOT take into account any GM material that may already be present on a given field due to the presence of GM volunteers, seed spilt from farm machinery, presence of GM within a seed lot or presence of wild relatives within a field. [20]

In addition, it took no account of the role of insects, weather and topography in long distance crop pollination. Thus the future of the English countryside and consumer choice is being based on a very weak data set which ignores evidence of long distance pollination events which Defra must have been aware of but chose to ignore.

4.2.c Out crossing to wild relatives
Oilseed rape is known to cross with several wild relatives native to Wales. Research shows the potential for the following species to hybridise with oilseed rape:

- wild turnip (*Brassica napus*)
- hoary mustard (*Hirschfeldia incana*),
- wild radish (*Raphanus raphanistrum*),
- white mustard (*Sinapsis alba*)
- wild cabbage (*Brasssica oleracaea*).

As a result of hybridisation monitoring carried out on some of the oilseed rape FSE sites , a single example of a cross with charlock (*Sinapsis arvensis*) was found which previously was thought to be impossible in the field[21]. It is impossible to say how frequently such crosses might take place without far more extensive research. However like the other relatives listed above a herbicide tolerant charlock would be a problem weed in most crops. Charlock/oilseed rape hybrids with a herbicide tolerance gene present could prove to be a costly weed to control for arable farmers in Wales.

If such crosses persisted and produced seed further cross pollination with other GM oilseed rape crops with different HT genes or even pest or disease resistance genes in the future, the result could be weeds with stacked genes which could confer a considerable advantage to them as weeds and possibly as wild plants outside cultivated areas. Accurate predicting the long-term impacts of such crosses would impossible in advance.

Maps published in 2002 by Friends of the Earth show the distribution of oilseed wild relatives and clearly demonstrate that in lowland Wales, where GM oilseed rape crops would be grown, sexually compatible wild relatives will never be far away[22].

Some modelling work to assess the out crossing of oilseed rape to wild turnip (which is found on river banks as well as an arable weed) in the UK estimated that there would be 32,000 hybrids along rivers and 17,000 in arable fields[23]. The out crossing of GM oilseed to wild turnip was established by a Defra funded project in Humberside where researchers confirmed high levels of transgenic materials in weed seeds including one wild turnip plant sampled which had 81 GM seeds out of a total of 167 (a rate of 48.5 per cent)[24].

4.2.d Feral oilseed rape

One possible source of GM contamination of non-GM crops of oilseed rape is gene transfer from populations of feral oilseed rape which frequently occur in field margins and along roads. Seed spillage during field operations or during transport to processing facilities are the most likely source of these populations although seeds may also be moved off transport containers by wind, or off field by animals/birds and during soil erosion events caused by wind or water.

Observations taken on the M25 motorway found that populations could be present for as long as 10 years but most were transient dying out after one or two years[25] due to competition from grasses growing strongly after wet weather in late winter/early spring. Densities of early populations were highest along the carriageway which lead to a oilseed rape processing plant at Erith in Kent. However, work in France[26] and Germany[27] has suggested that feral populations can be more persistent and that crossing with close relatives has taken place. Thus feral populations of rape can persist and act as a source of contamination of crops and wild relatives:

Transgenic varieties used in agricultural practice would in the course of decades spread outside the cultivated area to an appreciable extent and would also cross into neighbouring fields[28].

4.2.e Oilseed rape volunteers

Oilseed rape produces very tiny seeds which can be shed on to the soil from the ripened crop when pods shatter during harvest or can be deposited in the field via leaks from transport or via human feet and vehicle tyres. Most seed spilt or deposited on the soil surface in this way germinates if conditions are damp. However a proportion can be buried in the soil or fall into cracks and can become dormant until stimulated by cultivation to germinate several years later.

Seed dormancy in oilseed rape can last for 10 years or more[29].

One volunteer GM plant per square metre in a field of non-GM oilseed rape would produce contamination rates of between 0.6 and 1.5 per cent depending on variety[30]. Therefore, very few spilt seeds need to survive in the soil to mean that following non-GM crops would exceed the EU threshold of 0.9% for labelling. Up to 5 per cent of the crop[31] is subject to the pods shattering spreading seed prior to harvest or during harvest.

Another significant source of seed for volunteers is the residuals left in combine harvesters post harvest which could be deposited in a neighbouring field unless machines are stripped down and thoroughly cleaned between tasks.

For example. in evidence to a Science Review panel[32], Jeremy Sweet (then of NIAB) reported *" We found 6 kilos of seed in that combine harvester. It then went into a field of barley and harvested the barley, and that barley flushed out the rape seed and it all dropped into the ground. Now if you start doing that repeatedly on the farm you very rapidly start to have oil seed rape spread all around the farm and occurring in seed banks, and it becomes quite difficult to manage".*

To put this into context, 6 kg of oilseed rape seeds contains approximately 1.2 million seeds (1000 seeds weigh 5g). The normal sowing rate for oilseed rape is 120 seeds per m^2 meaning that a combine could contain enough seed to sow one hectare of crop if the seed was deposited evenly over the first hectare harvested. At the other extreme, if 2 seeds per square metre were dropped, there would be considerable scope for widespread contamination of following non-GM oilseed rape crops. Two GM volunteer plants per square metre would give a contamination rate in a following non-GM rape crop of 1.66%.

The length of dormancy for oilseed rape seed in the soil depends on soil conditions at the time of spillage and how the field is managed directly afterwards, The avoidance of burying the seed is crucial to prevention of dormancy but it always likely that some seeds will be buried.

The EC Scientific Committee on Plants reported that volunteers could arise from spilt seeds "for up to 10 years, possibly longer"[33]. Defra sponsored research on the impact of GM oilseed rape on crop purity predicted that some oilseed rape could survive for up to 16 years[34], if no attempts were made to control it, and still result in following non-GM crops exceeding the labelling threshold. This is to be expected given the numbers of seeds shed on harvest which in one trial averaged 3575 per m^2 (range 2000-10,000 per m^2)[35] . Modelling indicated that although the seed numbers in the soil had declined by 95% in year nine this would still leave 200 seeds per m^2 (66% higher than a typical sowing rate for the crop). Further evidence on the persistence of oilseed rape seed in the soil and its capacity to cause contamination in following crops comes from research in France on farm scale trail sites which commenced in 1995[36]. This monitoring GM occurrence over 3-8 years in the same field and found that the labelling threshold was exceeded in a third of cases and in one case contamination was as high as 18%. The research also found that contamination rates varied between GM varieties depending on seed shedding, seed dormancy and survival in the soil. The researchers also looked at how the growth of the non GM crops influenced the presence of GM volunteers.

An additional problem should several different GM oilseed rape varieties be licensed for growing in Wales would be the stacking of several traits in volunteer plants over several growing systems. In this way volunteers could acquire multiple herbicide tolerance genes or even pest and disease resistance genes. Gene stacking could alter the competitiveness and ability to survive of oilseed rape volunteer plants in arable fields and potentially in other habitats where they could become established to the point that they threaten other species. Predicting the long-term outcomes of such events would be impossible given our present state of knowledge. However, evidence from Canada has demonstrated that stacking occurred very soon after GM canola (oilseed rape) was first introduced. Individual plants with three HT genes present were found during field research[37].

It can be concluded that the management of GM volunteer oilseed rape plants in crops and stubble will be a constant and costly problem for Welsh farmers and could result in long term contamination problems which would undermine the long term vision for food and farming.

4.2.f Farm-saved seeds

Oilseed rape certified seed from merchants is expensive. Seed prices vary, depending on whether the variety is merchant's seeds or hybrid, between £9,000 per tonne to £15,000 per tonne[38] (sowing rates 5kg/ha at £45-75/ha and 4kg/ha at £36-60/ha respectively). To reduce the variable costs of oilseed rape costs farmers frequently use farm-saved seed either mixed with certified seeds or on its own. The National Association of Agricultural Contractors (NAAC) whose members clean and dress farm-saved seeds on farms, estimate savings on seed costs to be 25-50%[39]. We are not aware of any data on the extent to which farm-saved oilseed rape seed is used in Wales. One NAAC member estimates that the extent of farm-saved seed for oilseed rape could be over 50% of seeds sown. Farmers still make significant savings even after royalty payments and cleaning /bagging costs are taken into account.

The introduction of GM oilseed rape into Wales would have two potential impacts on farm-saved seed:

- Farmers who buy GM seeds would be prevented from saving their own seeds by the company selling it to them and would be required to sign a licenses agreement to that effect (this is standard practice in countries where GM crops are grown commercially). Any breach of these contracts would be likely to be pursued by the companies with a great deal of vigour using Plants Breeders Rights or patent legislation to ensure that they were fully compensated by the farmer for any saved seeds and for breach of contract.

- Contamination of farm-saved seeds from neighbouring GM oilseed rape crops would appear to be highly likely. This would mean that farmers would be showing a percentage of GM seeds (the examples of cross pollination outlined above (4.2.a) suggest that contamination rates above 2.5% could occur). Shedding of seed at harvest would mean that land could become contaminated with GM for many growing seasons which could result in following non-GM crops being required to be labelled because of the presence of GM volunteers in the crop. This could result in economic losses and seriously restrict future rotation options for farmers.

Thus the growing of GM oilseed rape in Wales could seriously threaten farmers' ability and right to save seed from their oilseed rape crops and cause long term contamination of seed lots and fields.

4.2.g Organic farmers

Organic oilseed rape is not a grown in Wales as far as we have been able to confirm. However, Defra statistics from the certification indicate a small area (0.3ha) of oilseeds (type not known) was grown in 2008 on land in the first year of conversion. The presence of commercial GM oilseed rape cultivation and in some circumstances the presence of GM test crops could mean it will never be a viable option because of the risk of contamination. In Canada, the cultivation of organic canola (oilseed rape) has ceased since GM varieties were first grown because contamination could not be avoided.[40] Attempts by organic farmers and organisations to mount a class action against Monsanto and Bayer (the companies responsible for introducing GM oilseed rape in Saskatchewan) have failed to get approval following two appeals. This has left individual court action as the only option for seeking redress[41] for the losses incurred. The long and costly series court cases between a conventional Saskatchewan farmer Percy Schmeiser and Monsanto[42] over the presence of GM volunteers on his land and farm-saved seed highlighted the costs and stressful nature of such a route for individual farmers. Schmeiser risked all by mortgaging his farm to cover legal costs, and eventually won compensation from Monsanto for the labour costs of hand pulling GM volunteer plants on his land. However, the Supreme Court ruled that Schmeiser had infringed Monsanto's patent by planting GM seeds from plants arising from seed blown from transporters onto his land. He was not required to compensate Monsanto because he never took advantage of the patented herbicide tolerance gene by spraying with Roundup.

5. Other Sources of Contamination

5.1 Honey

Honey bees use oilseed rape as source of pollen and nectar and beekeepers are sometimes paid to bring hives into fields by farmers to boost pollination rates and yields. Research for Defra suggests that the importance of insect pollination in oilseed rape may have previously been under estimated[43].

There are 250,000 colonies of honey bees in England and Wales[44] and a further 20,000 beekeepers may be unknown to bee inspectors. Inspectors check on the heath of bees because of the major disease and parasite problems which have hit bee colonies across the world. Mapping of apiaries is carried out by the Bee Inspectors and the map for England and Wales shows an even distribution throughout the lowlands[45] where oilseed rape is grown. As far as we know there is no separate record of the exact number of bee colonies in Wales.

Large-scale honeybee losses could adversely affect the pollination of strawberries, apples, pears and other crops and reduce yields in others, eg oilseed rape. In the UK as a whole pollination services and honey production are estimated to be worth around £200 million a year[46]. Honey bees and other insect pollinators (such as bumble bees, moths and beetles) are vital to the survival of plant species. Without these vital ecosystem services human food supply would be hugely reduced.

Pollination occurs because bees collect pollen grains as they visit pollen to collect food and they transfer them to other flowers where they brush off on stamens and fertilise the plant's ovum to start the development of seeds and fruit. Each bee can carry up to 60,000 pollen grains on its body hair[47]. Other wild pollinating insects work in a similar way. Research in Canada has shown that profits are highest if 30% of land is uncultivated within 750 metres of the edge of oilseed rape crops. This uncultivated land provides wildflowers for nectar and pollen when the crop is not in flower and also provides nesting sites for wild bees and host plants for other pollinators. Other studies have shown the importance of honey bees and other large pollinators for increasing yields. A trial in Australia where bees and other large pollinating insects were excluded from one part of the oilseed rape crops found that seed yield was 58% increased and seed weight by 46% when pollinators had access to the crop[48]

The British Beekeepers Association issued a policy statement on GM crops in January 2008[49]:

> *The British Beekeepers' Association, at its October 9th Forum meeting of members, deplored the situation that has arisen regarding the widespread introduction of GM trial sites without due consideration being given to the ethical and environmental impact that could arise through these trials.*

They also recommended a minimum separation distance between hives and GM crops:

> *The only short term advice that can be given is for beekeepers to move their colonies away from trial sites. A probable safe distance is in excess of six miles.*

If there is a reliable and large source of pollen, honey bees are willing to travel long distances. Researchers collected pollen from honey bees returning to the hive around a GM spring oilseed rape crop in Oxfordshire in 1999. Bees were found to be travelling at least 4.5 km (3 miles) to the field to collect pollen. Other researchers have found bees foraging on abundant sources of pollen over 9.5 km away from the hive[50]. Bumble bees are also important pollinators and research has shown they range up to 2km from their nest sites[51] but usually closer.

Recent monitoring of GM pollen in honey in Germany found that only 3 out of 21 samples were "very good" with 6 being were "unsatisfactory". Almost half the honey in the samples contained GM pollen. Many of the samples from S America contained GM soya pollen despite the fact that soya is not a very good source of nectar[52].

It is inevitable that Welsh honey will become contaminated with GM pollen if GM oilseed rape is ever grown in Wales which could damage sales given that the general public remains concerned about the presence of GM ingredients in food. The most recent consumer poll in the UK found that nearly two thirds of regular honey purchasers wanted a GM-free product[53].

6. Indirect Impacts of herbicide tolerant GM Oilseed Rape

The results of the UK's Farm Scale Evaluations (FSE) clearly showed that GM herbicide tolerant spring and winter oilseed rape with tolerance to glufosinate ammonium had a significant impact on the herb species in arable fields compared to the current herbicide regime used on conventional crops[54 and 55]. Herb species are important in farmland ecology because:

- they provide sources of nectar and pollen for insects;
- they provide a source of seed for farmland birds to feed on particularly in winter;
- they provide cover and insect food for birds and mammals.

The loss of flowering herbs from arable fields and margins could affect rates of pollination in other crops because of a shortage of nectar and pollen to sustain pollinators when crops are not flowering.

In addition, many arable weeds are now endangered because of the long history of herbicide use in arable crops and the advent of GMHT oilseed rape would make matters worse. Wales is home to five threatened arable plants listed in the UK biodiversity plan[56]:

- Cornflower (*Centaurea cyanus)*
- Red hemp nettle (*Galeopsis augustifolium)*
- Shepherd's needle (*Scandix pectin-veneris*)
- Spreading hedge parsley (*Torilis arvensis*)
- Flixweed (*Descurainia sophia*)

There was good evidence from the FSE beet crops, which compared glyphosate tolerant GM varieties with the current weed control methods for non-GM crops, that the impact of glyphosate tolerant oilseed rape on farmland biodiversity would be as bad or worse than that for glufosinate ammonium,. Glyphosate is a translocated herbicide and therefore kills the whole plant rather than the foliage. In doing so it is more effective at preventing weeds from flowering and setting seed.

The widespread introduction of HT GM oilseed rape in Wales could have a damaging impact on farmland wildlife as a result of reducing the numbers of flowering herbs in fields. The precise impacts on species which are included in the List of Species of Principal Importance for Conservation of Biological Diversity for Wales[57] will depend on the amounts of GMHT oilseed rape grown and whether other GMHT crops are also grown (for instance beet crops). The bird species likely to be affected include skylark, corn bunting, grey partridge, yellowhammer and linnet.

7. Wider Problems

7.1 Seed Purity

Since 2001 the European Commission has been seeking to introduce legislation at EU level to set a threshold for the presence of GM in certified non-GM seed lots sold to farmers. The latest proposal was for a threshold of 0.3% GM in oilseed rape seed. This equates to 3 seeds in every thousand. If agreed seed lots sold to Welsh farmers were contaminated to this level, widespread contamination would follow.

There is real potential for seed contamination to transfer GM traits into volunteer and feral oilseed [58]populations and wild relatives. This was highlighted by Statutory Nature Conservation Agencies in their comments on the EC proposals for the adventitious presence of GM traits in seeds. For oilseed rape they stated that the proposed threshold of 0.3 per cent GM presence would result in "up to 10,000 GM seeds per hectare" being sown. They also draw attention to this leading to the stacking of herbicide tolerant 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".

It would be in the interests of Welsh Farmers for the Welsh Assembly Government to support a zero threshold for GM presence in oilseed rape seed and in line with the overall strategy for agriculture and food in Wales

7.2 Adding to the Toxic Burden

The introduction of HT GM oilseed rape would result in particular chemical weedkillers becoming dominant. At present the most likely candidates would be glyphosate (Monsanto's Roundup) or glufosinate ammonium (Bayer's Liberty). However other GMHT crops could soon follow with tolerance to other chemicals such as 2,4D, dicamba and imidiazolene.

Roundup tolerant crops currently dominate the market for GMHT crops around the world (known as Roundup Ready or RR). The method of use adopted by farmers growing RR crops in North and South America has resulted in weeds developing resistance to glyphosate within a few growing seasons. As a result the early claims made of RR crops that they would reduce the amount of herbicide used and therefore reduce costs of production have not been sustained. Instead farmers are having to resort to using glyphosate mixed with other herbicides, soil acting herbicides and , in extreme cases, hand pulling of the most pernicious weeds. For more details of the escalating problem of weed resistance in GMHT crops see GM Freeze's briefing *Resistance is Growing*[59] .

Thus if Welsh arable farmers became very dependent of GMHT crops it seems very likely that resistance in weeds would develop fairly soon and this would result in an increasing dependency upon chemical weed control and an increasing toxic burden on the environment and food/feed chain.

Like all herbicides, glyphosate is designed to kill living tissue. Glyphosate alone is less toxic to mammals than some other pesticides. However there is evidence that Roundup formulations are much more toxic to mammals than glyphosate because of the action of other chemicals in the formulated product that allows it to stick to leaves more effectively and thus give the active ingredient a greater chance of penetrating the cells. Researchers concluded that the presence of adjuvants changes the permeability of human cells to Roundup and amplifies the toxicity of glyphosate: *"…the proprietary mixtures available on the market could cause cell damage and even death around residual levels to be expected, especially in food and feed derived from R* (Roundup) *formulation-treated crops," eve*n when very dilute doses were applied to human umbilical, embryonic, and placental cells[60]. Glyphosate's healthy image has been undermined by numerous research papers, and the chemical has been linked to several serious conditions including an increase in cases of non-Hodgkin's lymphoma[61]. It has also been linked to the reduction in amphibians and direct toxic effects have been demonstrated[62].

In order to facilitate the introduction of RR soya the maximum residue level for glyphosate allowed in crops for export was increased by two hundred times[63]. The use of glyphosate to desiccate cereal crops in the UK, just prior to harvest, produces frequent residues in grain, flour and bread. Data on residues in RR soya based products is not easy to obtain. However, soya based tofu, produced using Brazilian soya (origin of raw materials unknown) and purchased in the UK, contained glyphosate residues[64].

Other herbicides with resistance problems have also been shown to be toxic including 2,4D[65], atrazine[66], chlorsulfuron (a sulphonylurea herbicide listed for reproductive effects[67]) and dicamba (also listed for reproductive effects[68]).

7.3 GM and Health

The debates about the safety of GM food which began in 1999 with the publication of research by Professors Pusztai and Ewing on GM potatoes[69] modified to produce an insect toxin. This research suggested a link between feeding GM potatoes and damage to the immune system and growth rates of rats. This research provoked much scientific controversy[70] at the time but no follow up research has ever been carried out.

More recently, a team of French researchers[71] has re-analysed the data submitted in support of application to market three GM maize crops for food and feed use in the EU by Monsanto' They concluded;

Our analysis reveals clearly for the 3 new GMOs side effects linked with GM maize consumption, which were often sex-and dose-dependent. Effects were mostly associated with the kidney and liver, the dietary detoxifying organs, although different between the 3 GMOs. Other effects were also noticed in the heart, adrenal glands, spleen and hematopoietic system. We conclude that these data highlight signs of hepatorenal toxicity, possibly due to the new pesticide specific to each GM corn. In addition, unintended direct or indirect metabolic consequences of the genetic modification cannot be excluded.

There is also evidence that GM transformations can result in unexpected changes to allergenicity of a proteins produced in GM plants. Thus the absence of allergic reactions in one organism does not guarantee the absence of allergenicity of this protein, following genetic modification, into another organism. The possibility of the allergenicity of GM protein changing as a result of genetic engineering events was demonstrated by research on bean alpha amylase proteins when genetically engineered into peas. Researchers found the allergenic reactions occurred in mice fed the GM peas that had not occurred when they were fed non-modified peas or the parent non-GM beans[72].

GM technology can also result in unexpected changes in biochemical pathways in plants which could result in health implications. unexpected consequences of the GM events. For instance a potato modified to have low levels of the NAD-malic enzyme. This modification had the surprising effect of increasing the potatoes starch content - an outcome the research team was unable to explain[73]. A second example comes from Germany when an attempt to introduce a yeast gene to increase starch content had the opposite effect and several unexpected compounds were formed by the disruption caused to the metabolism[74].

There have been many critics of the risk assessment procedure applied to test the safety of GM foods and feeds over the years but the system adopted by the EU still replies on the concept of "substantial equivalence'[75]which assumes that GM feed is safe if the chemical composition of the GM food is shown to be generally the same as the non-GM equivalent. However, there is no defined list of what has to be measured and the system does not look for unintended effects, one of the major concerns that scientists have about GM food safety.

Thus the introduction of GM oilseed rape would bring with it potential health problems for people and farm animals which could be avoided by simply banning the crop. The main potential for harm would come from the feeding of rape cake to livestock.

7.4 Contamination of the Food and Feed Chain

As we have indicated above the task of containing GM traits within the field where a GM oilseed crop is planted, will prove to be impossible. The consequences of contamination of the food and feed chain could be very significant for the Welsh food economy. Contamination can arise from the smallest test site or from commercial releases. The economic consequence for non-GM or organic farmers of contamination could be significant and long term (if reputations are damaged). Examples of the severe economic impacts of crop contamination come from all over the world. The GM Contamination Register[76] contains details of 274 incidents of GM contamination since 1996. Major crops have been affected including maize and rice. The latter has been contaminated twice and on each occasion the GM trait concerned was unapproved anywhere in the world. Recent judgements in the US courts found in favour of farmers who had suffered sales losses as a result of Contamination with Bayer's LL601 rice[77].

A incident involving GM oilseed rape in Wales could be equally damaging to farmers suffering contamination and could result in costly clean up operations and protracted and expensive court action for those in the food/feed chain seeking re-dress. Not to mention the loss in reputation of Welsh production.

8. Summary

There is a strong science based case for banning GM oilseed rape in Wales based upon the high probability that it will prove impossible to prevent cross pollination from GM crops or contamination via seeds. Once contamination has occurred cleaning up the environment would be very costly and difficult. Contamination will also occur along the entire food chain which will undermine the viability of Welsh food producers because of loss of income or the costs of remediation.

Herbicide tolerant GM oilseed rape could threaten rare and endangered farmland species and create problem weed species. Experience elsewhere in the world suggests that weeds develop resistance fairly quickly in GM herbicide tolerant crops and if this were to occur in Wales could result in a significant increase in herbicide use in order to control such weeds adding to the toxic burden on the environment and food chain. GM oilseed rape would also bring with it the threat of health problems in people and farm animals.

This would run counter to the WAG's strategy for food, farming and the countryside[78] and the vision in the second Organic Action Plan for Wales [79] both of which place great emphasis on sustainable land use. GM oilseed rape does not fit this model of farming and food production.

We, therefore, submit that the Welsh Assembly Government should include a clause in its draft regulation on the coexistence of GM and non-GM crops banning the cultivation of GM oilseed rape. We recognise that this would not wholly remove the threat of contamination because of imports and cross border contamination incidents but it will make a clear statement of WAG's intention to keep Wales GM-free.

This submission was written by GM Freeze on behalf of Friends of the Earth Cymru, GM-Free Cymru, National Federation of Women's Institutes, Farmers' Union of Wales and The Organic Research Centre

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