Objecting to an Application to Trial GM Potatoes in Yorkshire

February 2010

Summary
This briefing provides details of an application to release GM potatoes in Yorkshire, and pages 5 and 6 set out grounds for objecting and requesting the rejection of the application to grow GM potatoes in Yorkshire, as well as conditions that should be placed on the trial should go ahead. **The deadline for objections is 5 March 2010.**

Background
The Centre for Plant Sciences at the University of Leeds has applied to Defra to conduct field trials of GM potatoes engineered to resist potato cyst eelworm or potato cyst nematode (PCN). They have applied for a Part B Consent for experimental release under the Genetically Modified Organisms (Deliberate Release) Regulations 2002[i]. This application (09/R31/1) is for entirely different GM potatoes than previously applied for by the University of Leeds in 2008 (see our February 2008 briefing *Objecting to an Application to Trial GM Potatoes in Yorkshire* at www.gmfreeze.org/uploads/GM_Potatoes_Cyst_Eelworm_final.pdf).

The trials would commence from 1 May to 3 November 2010 and continue for 3 years until 2012. They would take place at the Leeds University Farm at Tadcaster, North Yorkshire covering not more than 1,000 square metres with up to 4,000 GM plants per year.

The applicants state their objective of the trials as:

> *"To establish as a proof of concept the level of field resistance conferred on potato to potato cyst nematodes (Globodera pallida and G rostochiensis). A secondary objective is to establish any effects on non-target nematodes and certain other soil organisms for all plants."*

Potato cyst nematode
Potato cyst eelworm (PCN) is a nematode that attacks the roots of potatoes, reducing their yields. Losses can be very serious and depend on the severity of the infestation. Nematodes are thread-like worms commonly found in soil in the millions per square metre. Most nematode species are harmless to plants and are a vital part of the soil ecology and processes.

There are two species of PCN in the UK: *Globodera rostochiensis* (yellow PCN) and *G pallida* (white PCN). Both form bead-like growths on the roots of potatoes distinguishable by their colour to start with, *G pallida* being most common. Later in the life cycle both species turn reddish brown. Infestations become established from mid-July to mid-August and result in yellowing and wilting of foliage and hence loss of yield. Current controls, using pesticides and varieties resistant to *G rostochiensis,* have encouraged farmers to shorten their rotations and grow potatoes more frequently, and this has led to *G pallida* becoming more common. No varieties with high resistance to *G pallida* exist. Farmers may be tempted to shorten rotations if the PCN problems was perceived to "solved" to take advantage of the superior gross margins arising from potato crops compared with other arable crops[ii].

PCN survive in the soil as cysts, which can remain viable for 10 years or more. There may be as many as 25 million cysts per hectare in a badly infected field. Cysts can be spread about in soil on harvested potatoes, on other root crops, on equipment, on vehicle tyres and on footwear. In light or peaty soils wind and water erosion can transport cysts from field to field as well.

Infestations of PCN can be predicted by monitoring soil in advance of planting.

When cysts hatch, stimulated by chemicals exuded by potatoes, between 200-600 larvae are released in the soil. If the larvae fail to find a potato root they eventually die. Potato crops can cope with low level infestation, but yield losses are considerable if large numbers of females PCN invade the roots.

GM potatoes
Leeds University have applied to release four different GM potatoes:

- One has been modified with nematode gene to silence the cysteine proteinase gene, which inhibits digestion in PCN and reduces "parasitism success".

- The second also has a nematode gene, which does not confer resistance to PCN but will be used as a control during the experiment.
- A third modification using a maize gene mimics the PCN resistance genes already present on some potato varieties, such as Maris Piper, by disrupting cells at PCN feeding sites on the potato roots and is said to reduce damage.
- The fourth has a potato gene that also provides resistance to PCN. The trial will test the effectiveness of the resistance genes.

The trial could take place in closed conditions to avoid risk to the environment, rather than in open air trials as per the application.

The four GM potatoes in the trial are designed to produce GM proteins in different parts of the plant. The nematode genes are controlled by the cauliflower mosaic virus promoter to express throughout the plant, while the potato gene should be expressed in the roots only. The maize gene expresses in the feeding sites of PCN and in the anthers (the part of the plant where pollen is produced). This gene is said by the applicants to emasculate the plant (ie, make it sterile) to reduce the risk of cross-pollination.

Other genes used in the novel constructs are promoters from Thale Cress (*Arapidopsis thaliana)* and *Agrobacterium tumifaciens* (terminator sequence[iii] and promoter), and *E coli K12 (*antibiotic resistance maker).

The antibiotic resistant marker gene confers resistance to neomycin. Although this is from a group of antibiotic resistant genes approved by the European Food Safety Authority (EFSA) for use as markers in GM crops, the European Medicines Agency has challenged EFSA's opinion based on the potential importance of this group of antibiotics in medicine[iv].

The potatoes that have been genetically modified are the variety Désirée, which is known to consistently produce flowers, pollen and fruit (known as berries).

Previous trials in the late 1990s of the GM potatoes did not produce complete protection[v]:

> *"In a field test, the best lines of potato cvs Désirée and Sante transformed to express the cystatin provided > 70% and 85% resistance respectively, relative to the untransformed cultivars. However, when transformed Sante was exposed to a virulent G pallida population, the level of control declined to 51%. In more recent tests, transformed lines of Sante had improved resistance to G pallida and the best line prevented populations of the nematode increasing [16]. In a similar approach, a cystatin gene from the tubers of potato cv. Jersey Royal has provided significant control (60%) of G pallida populations when expressed in the roots of the same cultivar)."*

The results of more recent trials involving cystatin genes from rice and synthetic genes, conducted in 2008 and 2009 by the same group of scientists, have not been published so far[vi].

Current control measures

At present PCN is largely kept under control by the use of good hygiene, crop rotations, pesticides and using potato varieties that exhibit natural resistance. Bad infestations arise if these basic crop management techniques have not been followed. An additional safeguard practice in Northern Ireland, and soon in Scotland, is to test soil for the presence of PCN in advance of planting and to prohibit potato cultivation if the pest is present. Thus only "clean" land is allowed for potato crops. It is illegal to grow seed potatoes on land infested with PCN[vii].

The use of pesticides to protect crops against PCN accounted for 14% of applications of insecticides and nematicides usage, according to the latest pesticide usage survey (2006) for ware potatoes[viii] (57% by weight). In 2006 (the last year which statistics are available) 0.84% of the UK potato crop (1197ha out of a total of 141,000ha) was treated with the nematicidal pesticide 1,3 dichloropropene to control PCN. This represented 256 tonnes of the product or 0.2 tonne/ha[ix]. Approval for the continued use of Aldicarb (Bayer's *Temik*) to control PCN was withdrawn in 2003 and is completely banned from 2008. Three other granular nematicides are approved for use in the EC.

Alternatives to GM for controlling cyst eel

The follow measures can be used in combination to minimize the threat of yield loss due to PCN and negate the need for GM potatoes:

Good hygiene: To reduce the spread of PCN, cysts potato clamps should be made on the land that had grown the crop. Soil from potato washing should be only tipped on the land used to grow the crop. Machinery and vehicle tyres should be cleaned of soil deposits before vehicle leave the field, especially if they are shared between farms. Hedgerows around field should be maintained with good cover close to the ground to trap eroding soil. Sowing green manure as a ground cover will reduce the risk of erosion.

Good Husbandry: Soil should be tested for PCN before planting. Contaminated land should not be used, and only lightly contaminated land used as a last resort. Potatoes should be rotated with a minimum period of 5 years between crops, preferably longer if possible. Only certified seed potatoes should be used if PCN is present on a farm or area. The number of tubers lifted at harvest should be maximised and groundkeepers (potatoes left in the ground after harvest, which re-grow in the following season) dealt with promptly and effectively. Good soil management should be practiced to encourage rich and diverse populations of micro-fauna and flora to make it nematode "suppressive" and to encourage predators and parasites of PCN, as both exert control after a number of crop cycles[x].

Select Resistant Varieties: If land is contaminated with PCN to a low level, a resistant main crop variety should be selected or specialisation in early or second early varieties harvested before the cyst eelworms start to multiply. The current British Potato Council Potato Variety list[xi] has 77 out of 162 varieties tested for both forms of PCN exhibiting very high resistance to *Globodera rostochiensis* (47.5%). Very few score highly for resistance to G *pallida.* Very susceptible varieties with poor resistance to both species of PCN (often the older ones) should be avoided. Not all varieties have been tested for PCN resistance.

Future developments

Many different ways to control PCN have been researched apart from the GM. Some are more promising than others. A Rothamsted Research report for Defra in 2003 listed the possible methods[xii]:

- Antagonistic rhizobacteria
- Bacterial parasites
- Nematode-trapping fungi
- Fungi with adhesive spores
- Pathogenic fungi
- Bioactive compounds
- Trap crops (eg, potatoes or non-tuber-forming *Solanum* – the potato family – species)
- Isothiocyanates created by incorporating Brassicas into the soil
- Chemical to stimulate hatching of PCN
- High frequency electrical fields
- Microwaves
- Soil exposed to strong sunlight

Concerns about the current trial proposals

GM Freeze does not believe that the outdoor GM potatoes resistant to cyst worm can be justified at present.

Not in the interests of sustainable farming

If commercially grown, these GM potatoes may well encourage farmers to grow main crop potatoes on a much shorter rotation. This would not be in the interests of sustainable farming because it would:

- increase the risk of soil erosion (the bare soil in potato crops is prone to water and wind erosion),
- increase the risks of other potato pests and diseases (which number 600 in the UK) with a possible increase in pesticide use, and
- reduce soil nutrients leading to increased use of artificial fertilizers.

The applicant will use this trial to assess the impact of the GM potatoes on other soil nematodes, many of which are beneficial. GM Freeze believes that this research can be carried out in controlled condition in greenhouses without the risk of GM cross-pollination contaminating surrounding crops, as well as to prevent the occurrence of GM groundkeepers from potatoes left in the soil at harvest.

Genetic resistance bred naturally or through genetic modification can be overcome as the pest evolves. GM Freeze is concerned that the continuous presence of resistance proteins in roots where PCN parasitize potatoes will eventually lead to them overcoming the GM-induced resistance. This would be a particular concern if the GM potatoes were grown without regard to the other ways to prevent infestation, such as testing soil, good hygiene, long periods between crops and the other methods mentioned above.

Good husbandry is the best way to deal with PCN and makes GM unnecessary.

Risk of GM contamination
Despite the fact that the applicant claims that one of the GM potatoes on trial is “emasculated”, the other will produce pollen. GM Freeze is concerned that there are no proposals to limit pollen and berry production by removing any flowers from the crop, or to establish a separation distance to the nearest non-GM potatoes to reflect the distance that pollen has been shown to travel.

Distances for potato-to-potato cross-pollination events of up to 1km have been recorded in which pollen beetles were believed to be the vector.[xiii] Pollination is by insects including bumble bees, hover flies and pollen beetles (probably the most important). Long distance cross-pollination events have been found to occur. The applicants make reference to bumblebees visiting potato flowers.

Potatoes do not cross with close relatives very easily. Although there is no evidence to date that this has occurred in the field, two relatives (black nightshade and woody nightshade) commonly grow in farmland, and the potential for rare cross-pollination events in the field cannot be ruled out. The discovery of GM charlock (an oilseed rape relative) during the Farm Scale Evaluations provided some evidence that rare and improbable pollination events can and do occur. Their long term significance is very hard to judge without more knowledge of the likelihood of such events taking place.

It is important to note that if a non-GM potato flower was cross-pollinated by GM potato pollen the tuber of the non-GM variety would still be non-GM. Only the seed would contain GM material. Not all potato varieties flower and produce pollen. Some drop their flowers before fertilization. Others produce fruit (berries) but without viable seeds. Some produce fully fertile seed in their berries from which it is possible to grow new plants. Désirée is the best example from the commercially popular varieties which do set seed, and they have been selected for the proposed trial.

Use of antibiotic resistant genes
The presence of the antibiotic resistant gene (resistant to neomycin) is a major worry because it could be horizontally transferred to pathogenic bacterium, which would then itself be resistant. The European Medicines Agency have commented on the use of neomycin resistant genes in GM crops[xiv]. They expressed concern that the aminoglycosides group of antibiotics, which includes neomycin, could become more important in the future if antibiotic resistance in other groups increase. They pointed out that neomycin is currently used to treat bacterium infections, including TB, when other antibiotics fail due to resistance.

GM Freeze believes that the use of the neomycin resistance gene in the GM potatoes is unnecessary for the purposes of the trial, and that it should be removed before any planting occurs in or outdoors. The presence of the neomycin resistant gene would present a major barrier to the potatoes obtaining EU marketing approval, if they ever progress to that point, since there is widespread concern among member states. It therefore makes no sense to conduct trials with the gene still present.

Food safety
The applicants only briefly address the food safety aspect of the genetically modified potatoes. They make no reference to the possible allergenicity of this protein in the form it would be present in the GM potato.

Before testing and development of these GM potatoes progresses any further, well designed allergenicity tests should be carried out on them to look for cysteine proteinase proteins, which have similarities to cysteine proteinases, which are linked to allergic reactions from house mites. The genes will be expressed in every part of the potato including the edible tubers.

Secondly the lack of allergenicity of a protein produced in one organism does not guarantee the absence of allergenicity of this protein, following genetic engineering, 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[xv].

Other food safety concerns arise because of the unpredictable outcomes of genetic engineering events, as well as from the possible toxicity and allergenicity of GM proteins produced. There are at least two examples where experimental GM potatoes produced entirely unpredicted outcomes in the parent:

- a potato modified to have low levels of the NAD-malic enzyme produced the surprising effect of increasing the potatoes starch content – an outcome the research team was unable to explain[xvi], and

- an attempt in Germany 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[xvii].

Furthermore, research on GM potatoes modified to produce an insect toxin was published in 1999[xviii]. 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[xix] at the time, but no follow up research has ever been carried out.

The applicant does not provide any evidence to show it has looked for such unexpected events in their GM potatoes or safety data. While it should be noted that it is intended that the GM crop be destroyed at the end of each trial, lessons learned in other crops suggest that if this is not done thoroughly there may be extreme consequence (see contaminations of Canadian flax in 2009 and US rice in 2006, documents available at www.gmfreeze.org). Expert analysis of the GM construct and surrounding DNA may produce other issues of concern.

There is little point in field testing a crop for three years only to find that it fails the risk assessment for food and feed safety during any application for commercial release.

Want to object?

If you wish to object, the application reference number to quote is 09/R31/1.

Deadline for objections is 5 March 2010.

There are a number of grounds for objecting to the GM potato trials proposed by Leeds University:

1. There is ***no demand*** for GM potatoes now or in the immediate future, and therefore the trials represent an unnecessary risk to the environment and the integrity of the GM-free potato supplies in the UK.

2. There is ***no need to use GM*** for potato cyst eelworm resistant potatoes because conventionally bred resistant varieties are already available which, if used in combination with long rotations and good hygiene, can minimize yield losses. It is ***unclear how the introduction of GM PCN resistant potatoes will fit in with other sustainability objectives*** for farming, as they may lead to shorter rotations and increase risk of pollution, soil erosion and pest and disease build up.

3. There is ***a risk the GM pollen could be transferred by insects to other crops*** in the vicinity, and the GM seeds resulting could germinate to contaminate future non-GM crops.

4. ***GM groundkeepers (volunteers) could persist in the field*** for a number of years, certainly into a subsequent potato crops in the rotation if not controlled.

5. ***Small GM tubers could be transferred*** by machinery or even wild mammals off field to establish feral populations.

6. The applicants provide ***no evidence that unexpected side effects of the GM insertion have not taken place***, or that the applicant has any data on the food safety of the GM potatoes.

7. The ***presence of the neomycin antibiotic resistant marker gene*** raises concerns about the long-term risk of increasing antibiotic resistance in pathogenic bacteria should the GM potato receive commercial approval. It should be removed.

9. The ***applicant should demonstrate that they have proven that the GM proteins in the potatoes have not developed allergenicity*** as a result of the genetic engineering events before the experiment proceeds.

If the trial goes ahead Defra should place conditions on the release consent that would reduce the risk of any GM materials escaping or gene flow taking place.

The conditions should include:

- No other potatoes should be grown on the site for the duration of the experiment.
- All potatoes in the trial should be destroyed on site regardless of whether they are GM or not.
- A prohibition on future potato crops on the same land for 10 years.

- A requirement to monitor and control groundkeepers for 8 years.
- A requirement to remove flowers prior to pollination.
- A separation distance of 1.5 km between the trial and the nearest non-GM potato crop including those grown in allotments or gardens.
- Fencing to prevent wild mammals entering the site.
- Removal of the antibiotic resistant marker gene.

Send your Objection (stating the application reference number above, by **5 March 2010)** to:

GM Team, Department for Environment, Food and Rural Affairs

Area 8A LMB

Nobel House

17 Smith Square

London SW1P 3JR

or email gm-regulation@defra.gsi.gov.uk.

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[i] See www.defra.gov.uk/environment/gm/regulation/applications/07-r31-01.htm
[ii] See www2.defra.gov.uk/research/Project_data/More.asp?I=HH3111TPO&M=CFO&V=IACR
[iii] NB This is not Terminator technology designed to produce sterile seeds.
[iv] See www.emea.europa.eu/pdfs/human/opiniongen/5693707en.pdf
[v] Kerry B et al, 2003*, Investigations into Potato Cyst nematode Control,* Rothamsted Research, Defra Contract HH3111TPO available at www2.defra.gov.uk/research/Project_data/More.asp?I=HH3111TPO&M=CFO&V=IACR
[vi] See www.defra.gov.uk/environment/quality/gm/regulation/documents/07-r31-01-app-rev.pdf
[vii] Statutory Instrument 1993 No. 1320 The Plant Health (Great Britain) Order 1993.
[viii] Potatoes grown for food.
[ix] www.csl.gov.uk/newsAndResources/resourceLibrary/articles/puskm/arable2006.pdf p78.
[x] Kerry B et al, 2003 *op cit*
[xi] See http://varieties.potato.org.uk/reports/BPVD000101.pdf
[xii] Kerry B et al, 2003 *op cit*
[xiii] See www.soilassociation.org/web/sa/saweb.nsf/b0062cf005bc02c180256a6b003d987f/e502ce130dc0df3d802571cd004eb285!OpenDocument&Highlight=2,emberlin
[xiv] European Medicines Agency, 2007. *The presence of antibiotic resistant marker gene nptII in GM plangst for food and feed uses.* See www.ema.europa.eu/pdfs/human/opiniongen/5693707en.pdf
[xv] See www.pi.csiro.au/GMpeas/PI_info_GMpeas.pdf
[xvi] 2 BBSRC Business, Jan 1998. “Making crops make more starch” pp6-7.
[xvii] Gura, T. 2000 Reaping the plant gene harvest Science 287 pp412-414.
[xviii] Ewan, S.W.B. & Pusztai, A. (1999) “Effect of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine”. The Lancet 354: pp1353-1354.
[xix] *Review of data on possible toxicity of GM potatoes*. The Royal Society, London. 17 May 1999.