Bio Factsheet

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GM Farm Scale Evaluation Trials

In October 2003 the government announced the long-awaited results of its controversial farm scale investigations into whether GM crops were harmless or harmful for the environment. These were the trials that outraged environmentalists, who are strongly opposed to any GM crops. Crops were flattened, farmers taking part in the trials were threatened. The government set up consultation groups around the country to give ordinary people a chance to lean about and discuss the issues.

This Factsheet summarises the scientific approach taken and the results.

- Three genetically modified (GM) crops were used: beet, maize and oilseed rape.
- All three were genetically modified so that they were herbicide tolerant. Thus, they are known as genetically modified herbicide tolerant (GMHT) crops.
- Each of these 3 crops was planted in 60-70 fields in the lowlands of eastern and southern Britain.
- The sites chosen were representative of the areas where these crops are normally grown. Each field was split in two.
- One half of the field was planted with normal, non- genetically modified beet, maize or oilseed rape. The other half of the field was planted with the GMHT crop.

The crops were grown for 3 years. Over that time scientists measured and compared:

1. **The density of weeds in the normal and GMHT crop fields.**
   The weeds are the start of many food chains. If GM crops – or more specifically the herbicides used with them – significantly reduced weed density, then food chains outside the fields could be harmed. This might include damage to bird species – many of which eat crop pests, or act as pollinators etc.
2. **The number of weed seeds in the soil in the normal and GMHT crop fields.**
   Supporters of GM crops argue that even if the weed density in one year was reduced, this might not have a huge effect so long as the farmer used non-GM crops the next year. The weeds could recover as the seeds left behind in the soil germinated.. However, if the number of weed seeds in the soil was significantly reduced by GM crops, then this recovery might be threatened.
3. **The number and types of invertebrates on and in the soil in the normal and GMHT crop fields.**
   Invertebrates, particularly detritivores, are essential in nutrient recycling. If GM crops damaged these populations, the fertility of the soil could be reduced. Furthermore, invertebrates eat crop pests and many are the food source for birds.

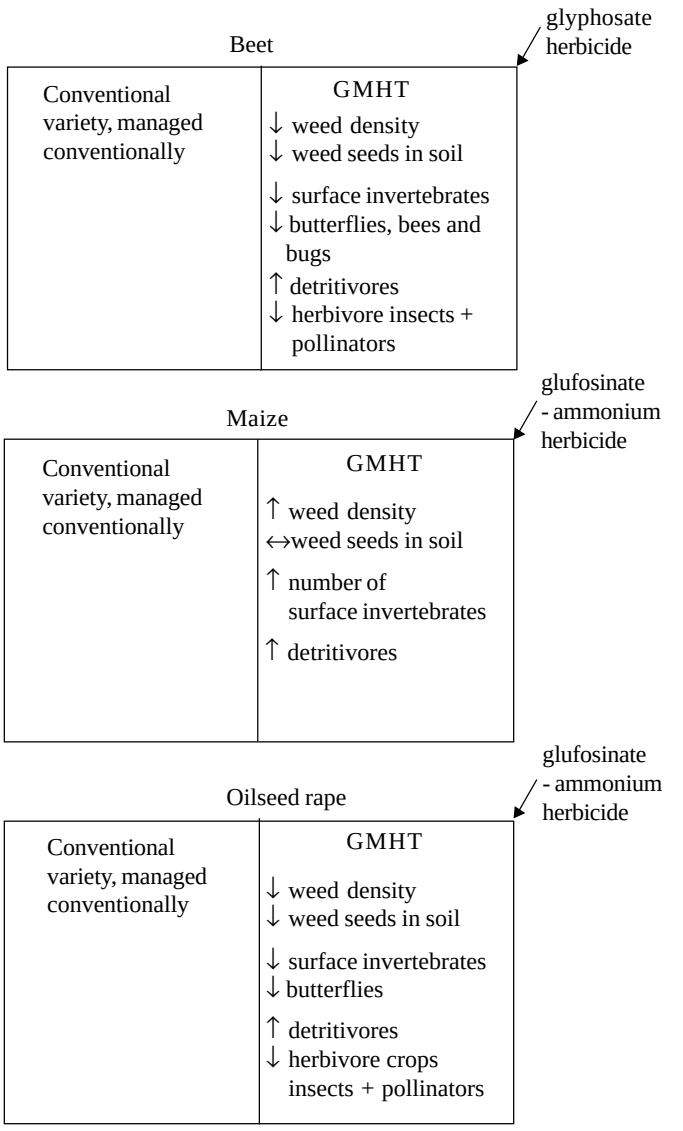
Table 1 summarises the major plant and animal species in the arable fields and their trophic importance.

Table 1. Crop pests

Taxon	Activity	Typical population (m^{-2})	Number of species in the field
Higher plants:			
Crop plants	primary producer	$10 – 10^2$	1 –2
Total buried seedbank	dormant primary producer	10^3 - 10^4	10 – 50
Weed population	primary producer	$10 – 10^2$	10 – 50
Plant-parasitic nematodes	Herbivore	10^4 – 10^5	10 – 50
Gastropoda (Slugs and snails)	detritus feeder, herbivore	$10 – 10^2$	5 – 10
Lumbricidae (Earthworms)	detritus feeder, seed eater	$10 – 10^2$	1 – 5
Insect herbivores and detritivores:			
Collembola (springtails)	detritus feeder, decomposer	10^2 - 10^5	10 – 50
Thysanoptera (thrips)	herbivores, predators, detritivores	10^2 - 10^4	1 – 10
Lepidoptera larvae (caterpillars)	herbivore (leaf chewer)	$10 – 10^2$	1 – 10
Symphyta larvae	herbivore (leaf chewer)	$10 – 10^2$	1 – 10
Chrysomelidae (leaf beetles)	herbivore (leaf chewer)	$10 – 10^2$	1 – 10
Curculionidae (weevils)	herbivore (leaf/stem chewer and miner)	$10 – 10^2$	1 – 10
Aphidoidea (crop aphids)	herbivores (sap)	10^2 - 10^5	1 – 5
Aphidoidea (weed aphids)	herbivores (sap)	$10 – 10^3$	10 – 20
Auchenorryhyncha (leafhoppers)	herbivores (sap)	$10 – 10^2$	10 – 20
Syrphidae adults (hoverflies)	herbivore (flowers)	0·05 or less	1 – 10
Lepidoptera (butterflies and moths)	herbivore (flowers)	0·05 or less	1 – 10
Hymenoptera, *Apocrita* (bees)	herbivore (flowers)	1 – 10	1 - 15
Insect predators:			
Syrphidae larvae (hoverflies)	specialist predator	1 – 20	1 – 10
Coleoptera: *Carbidae* (beetles)	omnivore, generalist predator	0·1 – 20	5 – 20
Staphylinidae (rove beetles)	generalist predator	1 – 10	5 – 20
Parasitic wasps (e.g. *Ichneumonidae*, *Brachonidae*)	parasitoid	1 - 10	5 – 20

Fig 2 shows the experimental set up and the main results

Fig 2. Experimental set up



Both herbicides are contact herbicides - they are absorbed into the foliage and don't stay in the soil

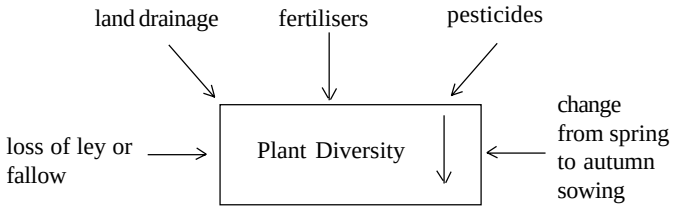
Broadly speaking then, the results were that:
GM beet and GM oilseed rape were harmful
GM maize was actually better for the environment than normal maize.

Environmentalists claimed the results showed that GM crops should never be grown in this country. Within one day of the results being released, Bayer announced it was closing its lab in Cambridge, with the loss of hundreds of jobs. It claimed that the timing was a coincidence.

Typical Exam Question
What precautions did the scientists have to take to make this a fair test?
- previous management of the field the same
- record number of seeds in soil before the experiment began
- soil properties to show these were typical of commercial practice
- method and time of application of herbicide used the same
- sampling techniques for seeds, weeds, insects etc same in all fields
- total area investigated under each treatment was the same

Plant diversity in arable fields has, in fact, been declining for the last 30 years. (Fig 3)

Fig 3. Plant diversity in arable land



Typical Exam Question
Suggest an explanation why of each of the factors in Fig 3 might reduce plant diversity.
Land drainage: some plants need wet conditions

Fertilisers: some plants require soils with low nutrient contents. In fertile fields, other species out-compete them.

Pesticides: may kill insects which pollinate a particular species

Time of sowing: crop germinates and starts growing earlier, out-competing the weed.

Loss of ley/fallow: no time for weeds to reach bare soil or germinate before cultivation/chemical treatment begins again

Analysing the results

The trials were not designed to investigate whether the changes in the number of seeds in the soil or in the number of invertabrates would have an effect on food chains in or outside of the fields. However, in the GM beet and oilseed rape, seed numbers were decreased by up to 80% compared with conventional beet and rape. The RSPB believes that there will be much less food for farmland birds if GM beet and oilseed rape are grown commercially. The maize trial showed that GM maize was actually better for the environment than conventional maize (GM maize had more weeds and more invertebrates (including detritivores). However, this was because the conventional approach to growing maize uses atrazine, a highly toxic, persistent herbicide that has just been banned by the EU. Critics say that because the three year maize trial used this herbicide – which no-one in the EU will soon be be able to use - the entire trial will have to be done again.

In perspective

Advantage of GMHT crops
- easier to apply herbicide
- the herbicides to which they are tolerant are less persistent than some used on conventional crops eg atrazine which is the most common pre and post emergent herbicide on maize

Disadvantages
- kill all weeds – so no food for herbivores – so no food for carnivores – food chain disrupted. Since the 1960s there has already been a decline in the invertebrate species diversity on arable farms
- herbicide tolerance might spread to other plants, including weeds, making superweeds

Over last 30 years agricultural intensification, encouraged by the CAP, has resulted in huge reductions in some bird populations :

Skylark ↓52%
Tree sparrow ↓95%
Grey partridge ↓84 %
Yellowhammers ↓53%
Corn bunting ↓88%

Bird populations are one of 15 key Quality of Life indicators used by the government, which has set itself the target of reversing bird population declines by 2020.

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Curriculum Press, Bank House, 105 King Street, Wellington, Shropshire, TF1 1NU