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Ministers and scientists urge rethink on GM crops

The government and scientists have urged the public and farmers to reconsider the benefits of genetically modified crops, which they say can boost yields and alleviate rising food costs. Research suggests real benefits for farmers and the environment are contributing to the rapid spread of GM crops.

The government appears to be reviewing its stance on genetically modified (GM) crops. In June, Environment Minister Phil Woolas told the *Independent*: "There is a growing question of whether GM crops can help the developing world out of the current food price crisis... Many people concerned about poverty in the developing world and the environment are wrestling with this issue."

In July, Professor Sir David King, the government's former chief scientist, went further, telling the *Financial Times*: "There is only one technology likely to deliver [the yield increases needed] and that is GM."

The idea found support at a recent conference at Cernobbio, Italy, on GM analysis – the growing business of detecting modified genetic material in seed and food. The conference, hosted by the European Commission's Joint Research Centre (JRC), considered the need for common sampling and analytical standards to ensure different laboratories obtain comparable results.

At the opening ceremony, eminent biologists who presented arguments that GM technology was needed to counter climate change and global population growth received rapturous applause from the international audience of analytical scientists.

Professor Marc Van Montagu, director of the Ghent-based Institute of Plant Biotechnology for Developing Countries (IPBO), said the need to improve food security, reduce agriculture's carbon footprint and replace petrochemical fuels and raw materials would demand the use of GM and other biotechnologies.

No health concerns had been reported from approved GM crops, he maintained, and a long list of beneficial environmental effects. "No alarming scenarios have been confirmed and the long-term ecological effects can be lower than those of traditional agriculture," he said.

Professor Chris Leaver, a specialist in plant biochemistry and molecular biology at Oxford University, said the challenge was to double agricultural production by 2050 in an environmentally sustainable way, without expanding the area of land used now. This would be needed to feed a growing population, provide raw materials for industry and stave off the threat climate changed posed to agricultural productivity.

"Agriculture should shift from chemical solutions to biological solutions in future to boost crop yield," he said. A new generation of GM crops would include not just single gene additions conferring herbicide tolerance or insect resistance but up to 12 traits including resistance to nematodes, viruses and fungi, improved vitamin content and better oil quality.

But has the first generation of GM technology delivered environmental or health benefits since it was introduced in the 1990s? One study suggesting it has comes from Spain, where the only GM crop to be licensed in Europe – Monsanto's MON810 Bt maize – has been grown widely. The study by scientists from the JRC's Institute for Prospective Technological Studies found it increased crop yield and reduced in pesticide use.[1]

Bt maize produces a toxin derived from a soil bacterium *Bacillus thuringiensis* which kills the larvae of corn borer moths, which are a major pest of maize. Spain grew 53,000 hectares of Bt maize in 2006 – 15% of the country's maize-growing area.

TOM TRACY PHOTOGRAPHY / ALAMY

Spanish farmers have reaped the benefits from GM maize where corn borer is a significant pest

The researchers conducted a face-to-face survey of 402 maize farmers, including GM adopters and non-adopters, in three Spanish provinces. They assessed the economic performance of the crop over 2002-04 and the farmers' socioeconomic profile.

The study found yields were variable but on average those of Bt maize were higher, particularly where corn borer was a significant pest. In Zaragoza, the region where the corn borer was most evident, yields were 11.8% higher.

Pesticide use also declined on Bt maize. On average there were 0.32 pesticide applications per year on Bt maize compared with 0.82 on non-Bt crops. Some 70% of Bt maize growers applied no pesticides, compared with 42% for non-Bt crops.

> **"No alarming scenarios have been confirmed and the long-term ecological effects can be lower than those of traditional agriculture"**
>
> **Professor Marc Van Montagu, IPBO**

Seed prices were generally similar for Bt and non-Bt varieties, but there was evidence that in Zaragoza, where pest pressures were greatest, merchants were charging more for Bt seed.

Because the value of Bt and non-Bt crops were similar – all being used for animal feed – Bt growers achieved the greater margins. This was €122 per hectare in Zaragoza, but much less in other areas at €3-9.5/ha. Farmers said they grew GM crops to reduce corn borer damage and to improve crop quality and yields.

A review of similar studies on the performance of GM crops in other parts of the world, also carried out by the JRC, concluded GM crops had spread rapidly in many countries because of on-farm and off-farm benefits.[2]

Despite European consumers' sensitivities, the uptake of GM crops has been rapid (see p 84 and ENDS Report 398, pp 38-42). The drivers, the study concludes, are a variety of benefits for farmers, including reduced weed or pest control costs, reduced ➜

tillage and sometimes, but not always, higher yields. For instance the use of herbicide-tolerant soybean – one of the main GM crops – did not increase yields but simplified crop management, allowing farmers more time for other activities.

It is therefore no surprise that a recent report by the UN-backed International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) found no evidence GM crops boosted yields (ENDS Report 399, pp 5-6).

It also notes that the spread of GM may have been checked in some areas because traits have not so far been introduced into varieties suited to all localities.

The JRC review also found that GM technology benefited small and large farmers alike. In China, smaller and low-income farmers derived greater benefit from Bt cotton than their larger counterparts. The study concluded that farmers were the main beneficiaries, with biotechnology firms as seed suppliers and the general public also benefiting.

Dr Emilio Rodriguez-Cerezo of the JRC's Institute for Prospective Technological Studies, one of the authors of both studies, explained: "GM technology is based only on seeds. It is suitable for small farmers because they don't need to do anything special." It has a more universal appeal than technologies such as 'precision farming', he said, which is dependent on crop and soil monitoring and the timely application of fertilisers or pesticides.

Greenpeace remains staunchly against GM technology which it believes threatens global food security because it lowers yields and puts natural biodiversity at risk. Its recent briefing paper on food security and the G8 summit maintains the technology is "expensive and risky for farmers and governments alike" and that the patents on seeds increase the price of food so will not alleviate poverty or hunger.

The rapid spread of GM crops across the world suggests this analysis is flawed. But as Dr Rodriguez-Cerezo points out, there has been little research on the effects of segregation in the seed market and the potential costs of coexistence measures to reduce cross-contamination of non-GM crops with GM genetic material. ■

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1. Adoption and performance of the first GM crop introduced into EU agriculture, JRC scientific and technical reports, EUR 22778 EN
2. Economic impact of GM crops worldwide, EUR 22547 EN

Farm study spotlights non-CO_2 emissions

Research by Natural England and a carbon calculator developed by the Country Land and Business Association will help farmers manage the climate impact of their businesses. The work has shown that nitrous oxide and methane make up 80% of farm greenhouse gas emissions.

Detailed figures for greenhouse gas emissions from 200 English farms have been produced for the first time, in a study for Natural England.[1] The figures will allow farmers to compare their emissions to established baselines for equivalent farms, and is the first step in gauging the climate impact of agriculture at farm level.

The Carbon Baseline Survey Project uses a new emissions calculator based on Intergovernmental Panel on Climate Change methodology, developed for the Country Land and Business Association (CLA). The calculator, Carbon Accounting for Land Managers (CALM), is available free of charge online.[2] The website has received 300-400 visits per month, but figures for completed calculations have not been collected.

The CALM process provides tailored, practical guidelines for reducing emissions by 20% by 2020. More speculative suggestions to achieve cuts of 60% by 2050 are also included.

The baseline survey comes as interest in farm greenhouse gases is growing. Emissions of these gases comprise 7% of the UK total, but have fallen since 1990 (ENDS Report 400, pp 25-26).

The Cabinet Office Strategy Unit has just published the results of a ten-month food policy assessment (see pp 47-48). It says: "Agriculture is... set to have a more prominent place in greenhouse gas abatement policies in the years ahead."

The Natural England study found emissions varied enormously between farm types. Annual emissions ranged from two tonnes of carbon dioxide equivalent per hectare for grazing livestock in upland areas to 11 tonnes of CO_2e/ha on dairy farms.

Emissions also varied with soil type, although only mineral and peat soils were considered. Peat drainage or cultivation are particularly associated with heavy CO_2 releases.

IN BRIEF

FISH MIGRATION POINTS TO CLIMATE CHANGE

Bottom-dwelling North Sea fish have responded to temperature rises over the past 25 years by migrating to colder, deeper waters, researchers have found.

Scientists from the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) in Lowestoft used data from a survey which has been collecting data throughout the North Sea every autumn since 1977.[1]

With colleagues in Norway and Canada, they analysed the depth and north-south distributions of 28 bottom-dwelling species between 1980 and 2004.

North Sea winter bottom temperature has increased by 1.6°C over the period, a rate of change greater than adjacent land masses and faster than the global average.

Most species in the analysis have a narrow thermal range of 4°C or less. The researchers found that bottom-dwelling fish have migrated nine metres deeper – 3.6m per decade – to maintain their preferred conditions. Coldwater species (22 of the 28 studied) deepened by 5.5m per decade on average, but up to 35 metres over the study period.

Importantly, the researchers ruled out fisheries exploitation as a reason. The temperature response was consistent across target and non-target species, so they suggest it could be used as a highly specific indicator of climate change.

North-south distributions were more heterogeneous, reflecting the complex interplay of temperature, ocean currents, and climate change.

The depth response of fish is similar to the altitude response of alpine species, but the consequences may be less severe. Mountain-dwellers face shrinking habitats and more likely extinction as they migrate uphill. In contrast, only the deepest-dwelling fish face similar geographical limitations.

1. Dulvy, N K et al, 2008, Journal of Applied Ecology, dx.doi.org/10.1111/j.1365-2664.2008.01488.x

One of the most interesting findings was that nitrous oxide (N_2O) and methane (CH_4) accounted for the highest emissions. For the 200 farms studied, 54% of emissions came from N_2O and 26% from methane, with only 20% from CO_2 (weighted according to their global warming potential).

According to the Cabinet Office, the lack of a price for these gases, similar to that for carbon, "is not sustainable or efficient in he long term". However, it recognises that mitigation at UK or EU level offers no benefit if farm emissions are simply exported.

Other pressures curb the potential to reduce farm emissions of these gases. The need to achieve high yields through the application of manure or chemical fertilisers will limit the ability to reduce N_2O emissions which are derived mainly from these sources. More also needs to be understood about how soil nitrogen breaks down to produce N_2O. Cutting CH_4 emissions, which result mainly from livestock, may also be difficult given rising demand for meat and dairy products.

Some emissions cuts are possible through precision feed and fertiliser application, and high prices are already driving farmers towards more efficient use. However, greater long-term gains will only be possible with ongoing research and development.

One area where progress is within reach is CO_2. Energy efficiency, use of renewables, and carbon sequestration through tree-planting can have a big impact on net emissions.

Eventually, the CLA would like to extend the CALM calculator, to cover more detailed farm and soil types and to calculate emissions per output rather than per hectare. This would tie in with increased interest in product carbon footprints for foods.

Companies are starting to look at food supply chain emissions to measure the carbon footprints of their products (ENDS Report 398, p 26). The British Standards Institute is developing a standard, PAS2050, for this purpose. It is due in the autumn. ■

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1. Carbon Baseline Survey Project 2008

2. CALM calculator

Scientists call for control on new greenhouse gas

Nitrogen trifluoride, a powerful greenhouse gas increasingly used to make LCD screens, should be reported and controlled by a post-Kyoto emissions agreement, according to US scientists.

Post-Kyoto greenhouse gas inventories should be expanded to include a new gas, nitrogen trifluoride (NF_3), say Michael Prather and Juno Hsu, of the University of California at Irvine. They argue that all heat-trapping gases should be reported – and potentially controlled – once annual global production exceeds five million tonnes of carbon dioxide equivalent ($MtCO_2e$).[1]

A post-2012 agreement to replace the Kyoto Protocol is anticipated at the UN Climate Change Conference in December 2009. The UN Framework Convention on Climate Change's secretariat said there were currently "no specific discussions on which gases should be covered under the post-2012 regime".

Prather and Hsu's paper, in a recent edition of *Geophysical Research Letters*, focused on the atmospheric lifetime and global warming potential (GWP) of NF_3. Virtually unheard of at the time of the original Kyoto Protocol negotiations, its use has soared in the past decade as a replacement for Kyoto-restricted perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

PFCs and SF_6 are widely used to make flat-screen displays, microchips and solar cells. These chemicals are used in plasma etching to cut out circuits on semiconductor chips or for cleaning chemical deposits from reactors.

Alternative NF_3-based processes were developed in response to pressure on PFC and SF_6 usage. Indeed, Air Products and Chemicals – the world's largest NF_3 producer – received a Climate Protection Award from the US Environmental Protection Agency (EPA) in 2002 for its work in this field, which "resulted in PFC emission reductions of as much as 85%".

Global annual NF_3 production has grown to an estimated 4,000 tonnes per year and is set to double by 2010. Unfortunately, it has a 100-year GWP 16,800 times greater than CO_2. If all the NF_3 produced this year were released, it would be equivalent to 67 million tonnes of CO_2. - equal to the emissions of some 3.5 coal-fired power stations the size of Drax, the UK's largest. But even though it is a very powerful greenhouse gas, much smaller quantities are released than the PFC and SF_6 it substitutes for.

With an atmospheric lifetime of 550 years, any NF_3 that is released is likely to accumulate

No one suggests that all NF_3 produced is emitted, not least because much is destroyed during use. But with an atmospheric lifetime of 550 years, any that is released is likely to accumulate.

However, atmospheric levels are not yet measured. Technical difficulties have held up Professor Prather's project to do this. Air Products agree NF_3 levels "should be measured and [we] are investigating techniques to do this".

There are conflicting reports on how much NF_3 is destroyed during use. Air Products claim "work with our customers finds that less than 2% of NF_3 is released to the atmosphere", corresponding to less than 80 tonnes per year.

Professor Prather suggests 200-400 tonnes per year could be emitted, once fugitive releases during manufacture and transport are considered. Based on UN Intergovernmental Panel on Climate Change guideline figures for process utilisation and abatement technology efficiency, Wen-Tien Tsai of Pingtung University in Taiwan estimated only 4-56 tonnes were emitted globally each year. But US emissions alone – already reported in their inventory of greenhouse gas emissions "for informational purposes" – were put at 40 tonnes in 2006. This is a rise of 1,200% on 1990 levels.

Eliminating emissions entirely is impossible, even using best available practice. As a result, Toshiba Matsushita Display Technology developed a cleaning process for its flat-screen plants using elemental fluorine. It says the process does not emit greenhouse gases or compromise cleaning efficiency and is cheaper.

Fluorine is highly reactive and cannot be transported easily, so it must be produced on-site. This requires extra infrastructure which may be a barrier to adoption.

The World LCD Industry Cooperation Council (WLICC) has committed to a voluntary emissions target for all fluorinated gases of $0.82MtCO_2e$ by 2010, including PFCs, SF_6 and NF_3. The commitment was the subject of a further Climate Protection Award from the EPA, in 2005. WLICC comprises national associations from the world's top three flat-screen makers: Japan (including Toshiba), Taiwan and Korea. In 2006, it invited producers from China (then the fourth largest) to observe at meetings, but they are yet to join. ■

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1. Prather M & Hsu J, 2008, Geophysical Research Letters, Vol 35, doi: dx.doi.org/10.1029/2008GL034542