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IF GM CROPS ARE EVER ACCEPTED, HOW WILL THEY HELP THE BRITISH FARMER ?

Could the UK be ready for a change ?

Just before he retired last December, after serving seven years as government chief scientific adviser, Sir David King, gave a valedictory speech. He covered many issues affecting agriculture and food, but most of the publicity following the speech centred on his stance on GM crops.

Sir David stated that " *By 2050 we will need to feed over 9 billion people on the planet - We will, I believe, only do this with the assistance of a third green revolution, and GM technologies will be crucial in delivery of this"* He also pointed out that as Britain is a world leader the science of molecular biology we should be encouraging the formation of companies that *" will lead the world in this green revolution".*

To date Government has taken a broadly neutral approach to GM issues with priorities to protect human health and the environment and provide choice for the consumer over whether or not to purchase GM food. Sir David's message was now *"I believe that it's now time to revisit this issue".*

A similar message was conveyed by his successor, Professor Beddington, as reported in The Times he told MPs*: "That he saw no safety reasons for opposing GM crops, which could help to boost farm yields and keep down food prices. Although GM technology would not be the right solution for every agricultural problem, and it would be important to assess the environmental impact, he said that the new crops should be considered on their merits, case by case".*

In the UK one of the main barriers preventing the introduction of GM food and therefore GM crops has been the stance taken by supermarkets. A BBC radio interview given by Mark Price, the managing director of Waitrose, last October, gave some indication of a softening of attitudes: *" We've always found ourselves in a leadership position, we were the first to take GM out and we may well be in a place where we have to explain to our customers why now it has to go back in. We are not at that point now; we may be in a few years' time."*

Sir David King's claim that GM technology will be important as a means of increasing yields, is however questioned by the Soil Association. Gundula Azeez, Policy Manager, makes the point that in managing plant biochemistry " There is no such thing as a free lunch ….introduction of a single trait gene will inevitably result in the plant compensating such that potentially negative responses in some other characteristic of the plant's growth will occur". The Soil Association's position is that alternative crop management systems would be a more fruitful route to follow. Gundula Azeez said that "To meet the yield objectives referred to by Sir David King, through GM technology, one would have to consider complex and lengthy multi-gene approaches, good for research scientists but a potential waste of resource"

What goes on overseas

In February, Dr Clive James, Chairman, International Service for the Acquisition of Agri-Biotech Applications, ISAAA, reported that in 2007 the global area of biotech crops had reached 114

million hectares, an increase of 12% over 2006. This area now represents 8% of the global area of cropped land. Clive James predicts that by 2015 the total area will have doubled.

90% of the GM crop area is in the Americas: USA, Argentina, Brazil, Canada, Paraguay. However important recent advances have been with insect resistant cotton in India and China, 6.2 and 3.8 million hectares respectively. GM crops were grown commercially in 23 countries, in which are living about 55% of the global population, and by 12 million farmers, of which 90% are small scale farmers in developing countries.

The European Union has now started growing insect resistant maize. The total area planted in 2007 exceeded 100,000 hectares, mainly in Spain and France. In France however, President Sarkozy took the step in December to formally suspend commercial use of GM maize until a biotech safety study had reported. In January he took it a step further and confirmed the ban for the 2008 season. It was admitted that this was a purely political decision. Small areas were also grown last year in Germany, Portugal, Czech Republic and Slovakia.

GM crops grown commercially. ISAAA 2007

Crop	**Area Million hectares, 2007**	**Proportion of global crop area** (cf. 2006 totals)	**Main traits**
Soya beans	58.6	63%	Herbicide tolerant
Maize	35.2	24%	Insect resistant, herbicide tolerant
Cotton	15.0	43%	Insect resistant, herbicide tolerant
Canola	5.5	20%	Herbicide tolerant
Others: papaya, squash, alfalfa, rice	small		Disease resistant, herbicide tolerant
Total	114.3		

The technology so far has been dominated by just four crops. These crops are core to American agriculture, which is where the first commercial introductions took place in 1996. Molecular scientists achieved the necessary genetic modifications in these crops early on, and there was relatively little public concern over the technology.

But the real reason that these crops remain so dominant is down to the fact that farmers, are satisfied that they do a good job. Usage has continued to expand despite the high cost of seed and the associated technology fee that may be called for.

Weed control in soya beans with conventional herbicides is a chancy operation. Late flushes of weeds often call for application of post emergent herbicides which can result in some shock to the crop and risk of yield loss. With glyphosate tolerant beans selectivity is total. Furthermore the flexibility of herbicide application has encouraged a major trend to minimum tillage production.

One of the major pests of maize in North America, and central Europe, is the European corn borer. It is a sporadic problem but if it occurs it can dramatically reduce yields. Emergency control has to be by costly helicopter application, dropping insecticide granules into the whorls of the crop. So breeding insect resistance into the maize as an insurance is a real advantage.

Cotton is notorious for its insect pests. Genetically modified Bt cotton can replace the need for many aerial applications of insecticide to control different bollworm pests.

With canola, in Canada, the conventional herbicides available are soil acting. The crop is planted in the Prairies in the spring and if, as is often the case, there is not enough rain the herbicides fail. Consequently the arrival of glyphosate or glufosinate tolerant canola has been a god send. Over 80% of canola grown in Canada is now herbicide tolerant, most of it GM.

We import but we do not grow

Apart from the recent plantings of Bt maize in Spain and France, the EU has steadfastly kept away from registering GM crops for production in the EU. However we are importing vast quantities of genetically modified staple crops for livestock feed. Soya beans, a basic source of protein, comes from both North and South America. Initially the European supermarkets encouraged poultry and pork producers to rely on non GM beans. But with Brazil, Argentina and the USA all predominantly converted to GM, supplies of non-GM options are simply not available except at a very high price.

The same is true with corn gluten from the USA. In fact, for a period last autumn it looked as if poultry producers would have to consider closing European operations altogether. American plantings of higher yielding GM corn varieties, notably Pioneer's Herculex, had jumped, responding to demand for biofuels, and at the expense of conventional varieties. EU registration, and therefore import clearance, for gluten from these GM varieties had not been granted, even although applications had been made as early as 2004. The consequence was that the price of corn gluten from conventional varieties had sky rocketed. EU registration of Herculex was eventually granted in November.

The extent to which the UK livestock feed industry is using GM was highlighted by a report published by the Soil Association, published last November. It stated that around 60% of the maize and 30% of the soya used in dairy and pig feed in the UK is GM. It also suggests that, contrary to the assurances from the Food Standards Agency, small amounts of GM DNA end up in milk and animal tissues of GM-fed animals. Gundula Azeez therefore considers that: " There are important safety issues which livestock farmers should be aware of"

Colin Merritt, External Affairs and New Business Development, Monsanto UK Ltd takes the view: "That Herculex was just a drop in the ocean compared with what will happen when a raft of new GM crops are commercialised in soya and maize over the next 2-3 years.

From my perspective we are entering a new phase in the global biotech saga. There was a time, around 1999-2000, when it appeared that the GM crisis in Europe might stall this development internationally. The fact is it hasn't. And now the rest of the world has basically turned the page and is progressing, leaving Europe increasingly isolated from world agricultural progress, and risking a food supply crisis here within a few years".

" Soya beans and corn gluten are never going to be UK produced commodities but it seems totally scandalous that we are importing GM crops but not able to grow them"

Paul Temple, deputy President of the NFU, is concerned that both the livestock sector and the arable sector is threatened due to the delays in EU registrations. " Faced with the escalating feed prices, the European Commission has reported that up to 40% of the pig and poultry production industry could be lost from the EU. And this sector is the largest outlet for our cereals so the arable producer could also be affected"

Where are the opportunities in Britain ?

A number of crop traits have been evaluated in the UK:

Herbicide tolerant sugar beet

Effective use of selective herbicides in sugar beet, while maintaining adequate safety to the crop has always been a challenge. The crop is slow to become established so that competition against what is usually a wide range of broad leaved and grass weed species is poor. Timing of applications is critical and late flushes of weeds can often necessitate further treatments. Even with the choices of selective herbicides available, multiple applications are invariably necessary.

So it was no surprise that weed scientists at Brooms Barn Research Centre, saw the use of GM herbicide tolerant sugar beet, based on glyphosate, as one of the potentially most useful applications of biotechnology in the UK. Much of their work was reported as far back as 2003.

Mike May, Senior Liaison Officer at Broom's Barn, could see the practical as well as the economic benefits. The fact that all weeds could be controlled through the application of glyphosate means that timing of application, invariably dictated by weather conditions, is far more flexible than with conventional herbicides.

The key finding was that overall savings, net of technology fee included in the seed price, would be £150 / ha / year, or £23m per year if GM herbicide tolerant crops were grown exclusively. A major part of this saving is the 80% reduction in expenditure on herbicides.

Mike May, said then that: "This economic analysis now quantifies the potential financial benefits of growing GM beet and thus the positive impact on industry competitiveness and affordability of agri-environment measures. The potential saving that GM herbicide tolerant sugar beet provides could be critical to the future competitiveness of the UK sugar beet industry at a time when profitability is at risk." He now adds that "The recent changes in the EU beet regime mean that this comment is still true, even if the actual saving is now slightly less than £150/ha. Furthermore beet is moving closer to factories and this is likely to mean a

closing up of rotations, and a greater incidence of weed beet. GM herbicide tolerant would help to solve this problem"

Research results have also shown that management of GM herbicide tolerant sugar beet had the potential to provide significant environmental benefits. A weed-management system based on glyphosate tolerant sugar beet has also been extensively tested at Broom's Barn. This demonstrated that weeds can be retained for longer in the season without affecting the crop yield. Weeds and associated insects provide vital food and habitats for the farmland birds and other wildlife, which have dramatically declined as a result of intensive farming systems.

Mike May explained the system: "Glyphosate can be band sprayed over the sugar beet after early crop and weed emergence, to ensure that the crop is not affected by weed competition. Between the rows weeds are then left, up to as late as July, when a second overall application of glyphosate is made"

Compared with the conventional treatment of multiple applications of herbicides the GM sugar beet route offers the benefit of reduced risk of soil erosion and enhanced insect and bird presence. In the trials carabid beetle populations nearly doubled and staphylinid beetles increased by a factor of 3.5-7.0.

"Frequent spraying destroys the weeds on which the insects and birds feed, but our system means we can reduce the amount of spraying and allow weeds between the rows to flourish in summer without affecting yield"

The reason glyphosate tolerant sugar beet failed in the ecological criteria set by the Farm Scale Evaluation trials was that no weeds were left and therefore no insects. Brooms Barn have since addressed this issue with a different approach, by leaving unsprayed mitigation strips, one row in a 100.

Herbicide tolerant maize

The traditional weed control method for maize had been atrazine based on its unique combination of selectivity to the crop and the broad spectrum of weeds controlled. However over the 2003/04 period atrazine was withdrawn, in the UK and elsewhere in the EU..

Bayer CropScience UK had been testing GM glufosinate tolerant varieties based on Chardon LL (T25) forage maize since 1999. Dr Julian Little, observed that: " It was clear that, in a non-atrazine world, the ease of management offered by broad spectrum post emergent herbicide applications would be immense. The combination of reduced costs and flexibility of timing was attractive for the grower. Furthermore the flexibility of timing gave the potential to manage the crop with consideration of the environmental benefits, allowing insect populations to build up on the weeds, of benefit to birds and small mammals"

After the Farm Scale Evaluation trials, the only GM crop that was given Government approval was Chardon LL maize, announced by the then Environment Minister, Rt Hon Margaret Beckett, in March 2004. However the approval was conditional upon further studies.

By the time that the approval was granted the varieties chosen were already becoming outdated. Consequently Bayer CropScience, faced with even further delays, could not justify continued development and announced its intention to cease activities with the trait in the UK and elsewhere in the EU. A key factor behind the decision was that Bayer did not have its own in-house maize breeding capability. The Chardon lines had been acquired from Advanta.

Herbicide tolerant oilseed rape

With both glyphosate tolerant, Roundup Ready, and glufosinate tolerant, Liberty Link, canola commercialised in Canada, application of the traits for both winter and spring oilseed rape was a target for the UK by both Monsanto and Bayer CropScience. The agronomic benefits are flexibility of time of application with the option for minimum tillage. Compared with two, and often three, herbicide applications needed with conventional herbicide treatments, with GM herbicide tolerant crops one early post emergence treatment usually suffices. A later application can be considered if necessary. There are therefore substantial saving in fuel costs.

With glyphosate tolerant oilseed rape there are cost saving benefits. With Bayer CropScience's, varieties based on the MS8RF3 trait, there are quality and yield benefits, in addition to the glufosinate tolerance. In trials over three years in the UK, the winter crop averaged a 14% increase in yield compared with conventional varieties. With the spring crop it averaged a 20% increase.

However, the outcome of the Farm Scale Evaluations, reported in 2004, was that there were potential negative impacts on the ecology. Furthermore EU approval has yet to be granted. Defra have indicated that if it is demonstrated that the use of this crop is not deleterious to biodiversity, they would look at it again.

Blight resistant potatoes

BASF are a relative late comer into agricultural biotechnology with a potentially major breakthrough in the form of a blight resistant potato crop. The trait demonstrating resistance to the fungal disease is based on the expression of two separate genes derived from wild mexican potatoes. These wild species demonstrate resistance to *phytophera infestans*, the causal agent of blight.

In December BASF reported on the results of the first UK field trial carried out at the National Institute of Agricultural Botany, NIAB, Cambridge. BASF's Barry Stickings said: "The results from the first year of the trial are extremely positive. The wet weather conditions really tested the technology. The non-GM varieties were badly hit by blight but the GM varieties showed strong resistance." 2007 was a particularly good year to test the trait with the high blight pressure creating a need for some growers to spray as many as 15 times.

Although activists attempted to destroy the trial in July, and large parts of the plots were damaged, sufficient plants remained for BASF to be able to assess the effectiveness of the genetically improved potatoes..

Barry Stickings believes that " This trial will lead to a real opportunity for UK farmers who need new tools to control a severe disease that causes global crop damage costing up to £2bn a year."

Professor Wayne Powell, Chief Executive, NIAB, said: "The material we assessed was placed under extremely high blight pressure this year. …. we have been able to collate valuable and meaningful results, and provide an independent, science-based perspective on the blight resistance trait."

Similar positive results have been obtained in Sweden, Germany and the Czech Republic. BASF is planning a second trial at the site in Cambridge for Spring 2008.

Farm scale trials remain vital

As a consequence of concerns on the environmental impact of GM herbicide tolerant crops the establishment of a Farm Scale Evaluation, FSE, programme was commissioned by Defra, with the first trials planted in the spring of 1999. In this respect the UK was ahead of other EU countries in choosing to evaluate the environmental impact and demonstrate the agronomic benefits under practical farming conditions.

Dr Julian Little is now Chairman of the Agricultural Biotechnology Council, abc, the UK industry association. His regret is that despite the clear agronomic and economic advantages shown, it was the possibility of negative impacts on the ecosystem, in a very worst case scenario, that dominated the decision process at the time.

Julian Little, says of the FSEs, " The concept was good but perhaps they were ahead of their time. There were no concerns then about food security, biofuels were not part of the equation nor was the concept of climate change and carbon footprint so prominent"

He does not claim that GM technology is the only way forward and recognises the need of organic growers aiming to add value to their produce in response to a particular sector of the market. " But it should be horses for courses, giving the consumer a clear choice"

Paul Temple, Deputy President of the NFU, explained that the NFU support choice for the consumer and that it is not their role to dictate to farmers what they should grow or to promote one agricultural system in favour of another. "Ultimately the market will rule".

He personally has had the opportunity to see the benefits of GM crops from trials in the UK and elsewhere in the EU. He now believes that, and despite the loss of the Experimental Husbandry Farms, it is important that members have the opportunity to see trials, under UK conditions, for themselves.

What for the future ?

Colin Merritt lists some of the next wave of GM crops which will begin commercialisation over the coming 5 years: “These include drought tolerance, improved animal feeds, healthier vegetable oils and improved nitrogen utilisation. The latter alone has the potential to reduce nitrogen use per tonne of crop produced by up to half “

Mike May believes there are many more potential benefits for the sugar beet grower yet to come: “ We do not know for sure what is 'sitting on lab shelves' waiting for GM cropping to start in Europe. I know of genes that will improve rhizomania resistance in beet, there is another that could be used to suppress rots”

For British farming it is unlikely that there will be either uncontrolled adoption or, in the long run, total rejection. Sir David King referred to the UK’s research skills in molecular biology. To this should be added the scientific and practical experience gained in developing, demonstrating and managing efficient, and environmentally sound, crop production systems. With new traits yet to come there is every opportunity for UK scientists and farmers to adopt a fresh approach and to exploit the technology for the benefit of all.