ASSOCIATE PARLIAMENTARY FOOD & HEALTH FORUM

GM Crops and Food Security 2010-2050

FHF half-day summer conference

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2.30-5pm, Jubilee Room, House of Commons

Are GM crops necessary to secure global food supplies at affordable prices? Dr. Martin J. Hodson (Oxford Brookes University)

Thank you for inviting me to speak today. Before attempting to answer the question, "Are GM crops necessary to secure global food supplies at affordable prices?" I think it is important to put the question in context. We are looking at the world human population going up from around 6.8 billion now to 9 billion by 2050 before it begins to level out. At the same time we are almost certain that whatever we do now some amount of global warming will happen, causing more heat waves, droughts, floods and extreme weather events. We can add to that concern about decreased fossil fuel availability. In December 2009 the UK Energy Research Council suggested that we would certainly reach global peak oil production by 2030, with a reasonable chance that it might happen by 2020.[1] So what kind of improvements are we looking for in our crop plants this century? To feed all those extra mouths we need plants with

[1] UKERC (2009) *Global Oil Depletion. An assessment of the evidence for a near-term peak in global oil production*, London, UK, UK Energy Research Centre's Technology and Policy Assessment.

greater yields. We also need plants that are able to produce high yields in stressful environments- high temperature, drought and salinity. And we need plants that will have less reliance on fossil fuels. For example most of our nitrogen fertilizer is produced using energy from these sources. If we stopped using nitrogen fertilizer we would see a major decrease in food production when we are looking for an increase.

Now to GM Crops. The 2009 Report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) says this, "Biotechnology has always been on the cutting edge of change. Change is rapid, the domains involved are numerous, and there is a significant lack of transparent communication among actors. Hence assessment of modern biotechnology is lagging behind development; information can be anecdotal and contradictory, and uncertainty on benefits and harms is unavoidable. There is a wide range of perspectives on the environmental, human health and economic risks and benefits of modern biotechnology, many of which are as yet unknown."[2] This statement refers to biotechnology in general, but is a warning to us all when we consider the thorny topic of GM crops. This afternoon I will try to give a balanced overview of the science of GM crops without getting into the even more complex areas of environmental impacts, ethics, policy, economics, globalisation and public perception. I think these will come out with other speakers this afternoon.[3]

[2] International assessment of agricultural knowledge, science and technology for development (IAASTD): synthesis report with executive summary: a synthesis of the global and sub-global IAASTD reports edited by Beverly D. McIntyre et al. (2009) p8.

[3] For a simple introduction to these topics see Hodson, M.J. and Hodson, M.R. (2008) *Cherishing the Earth.* Monarch: Oxford. pp 182-188.

What kind of GM crops do we have, and what is being worked on? At the moment 99% of the GM crops grown in the world are of two types. There are herbicide resistant crops that allow farmers to kill weeds, but without killing the crop. And there are insect resistant plants that have been engineered to produce a natural insect toxin taken from a bacterium called *Bacillus thuringiensis*. In general these have been shown to have improved yields, and a survey published in Nature this year suggested this could range up to about 30% for insect resistant crops. Economic performance was improved in 71% of trials with herbicide-tolerant crops, and in 74% of trials for insect-resistant crops.[4] However, it is worth noting that there are growing numbers of reports of herbicide resistant weeds causing major problems for GM herbicide-tolerant crops.

The second generation of GM crops will include plants that have been engineered to produce more vitamins, or contain more essential minerals such as iron. The most famous of these is Golden Rice. This has been produced by genetic engineering to make precursors of beta-carotene in the grain of rice, and these have a yellow colour as a result. Golden Rice was developed to be used in areas where there is a shortage of vitamin A in the human diet. It looks like it may be commercially available in some Asian countries by 2012. Golden Rice has, however, had much opposition, particularly from the anti-globalization lobby. Other GM crops are now being developed to produce medicines such as vaccines.

[4] Carpenter, J.E. (2010) Peer-reviewed surveys indicate positive impact of commercialized GM crops. *Nature Biotechnology* **28**, 319-321.

So the presently used GM crops do allow for some increase in yields, which could be helpful in increasing food production even more in the future. Then there are a range of crops which may be valuable for improved diet or producing medicines. But where will the big gains come from? At present I am writing an undergraduate plant science textbook, and as I have been working my way through the literature I have come across several ideas:

1) Plants show a number of types of photosynthesis. Most plants are known as C3, and include wheat, barley, and peas. Some 3% are C4, including maize, sorghum and sugar cane. C4 plants are more efficient at harvesting carbon dioxide from the atmosphere, and grow better in water limited conditions and at high temperatures. So why not transfer the genes for C4 from maize to wheat?[5]

2) It may be possible to produce plants that are more able to deal with stressful environmental conditions, such as cold, extreme heat, drought or salinity. However, it is worth pointing out that those plants that are naturally found in such environments tend to grow very slowly, and have poor yields. I worked on salinity resistance for my doctorate in the late 70's and the idea of salt tolerant GM crops was frequently discussed then. Now, 30 years on, there is still little sign of success. Rana Munns, one of the world's leading experts on salt tolerance in plants wrote in 2005, "More than 700 patents have been granted that invoke salt tolerance as part of the invention, most involving specific genes. However, the successful use of these genes to produce a salt-tolerant cultivar is very slow."[6]

[5] Sage, R.F. (2004) The evolution of C_4 photosynthesis. *New Phytologist* **161**, 341–370.

[6] Munns, R.(2005) Genes and salt tolerance: bringing them together. *New Phytologist* **167**, 645–663.

3) We have mentioned that nitrogen fertilizers might become scarce as fossil fuels decrease in availability. Legumes like peas and beans have bacteria in their root nodules that can take nitrogen out of the atmosphere and provide it to the plant. One idea that has been around for a long time is to transfer the genes for nitrogen fixation from legumes to cereals.[7]

These three ideas sound great, but the problem with them all is that, unlike herbicide resistance, the processes are controlled by many genes, and are horrendously complex. It would be foolish to say that they can never be done, but do not underestimate the difficulties. Many scientists are putting the development of commercially available drought resistant crops back 20 or more years into the future.

What are the overall conclusions on GM crops? 1) GM crops already available do show some increases in yield when faced with weed and insect pests. 2) the really big gains in yield that we need to secure global food supplies at affordable prices are likely to be much more difficult to achieve.

My question “Are GM crops necessary...” tends to imply that I should also look at alternatives. Where do we go to find them? The IAASTD report is a good place to start. IAASTD in 2009 concludes its section on biotechnology as follows: “While climate change and population growth could collude to overwhelm the Earth’s latent potential to grow food and bio-materials that sustain human life and well being, both forces might be offset by smarter agriculture. Present cultivation methods are energy intensive and environmentally taxing, characteristics that in time both

[7] Cheng, Q. (2008) Perspectives in biological nitrogen fixation research. *Journal of Integrative Plant Biology* **50**, 786–798.

exacerbate demand for limited resources and damage long term productivity. Agroecosystems that both improve productivity and replenish ecosystem services behind the supply chain are desperately needed. No particular actor has all the answers or all the possible tools to achieve a global solution. Genetically modified plants and GM fish may have a sustainable contribution to make in some environments just as ecological agriculture might be a superior approach to achieving a higher sustainable level of agricultural productivity."[8]

So IAASTD, at least, sees GM techniques as only part of the kit bag to improve crop yields this century. They would see measures to improve soil and water conservation, to decrease reliance on fossil fuels and increase carbon sequestration as equally, if not more, important than GM crops. GM does not appear to be the total answer to the problems of producing enough food, and smarter agriculture will undoubtedly be needed. At the moment it is highly uncertain how good GM crops will be, and how quickly plants that have increased yield, can deal with stresses better, or can harvest their own nitrogen from the atmosphere will become available.

"Are GM crops necessary to secure global food supplies at affordable prices?" If I am honest, I am not sure that any type of agriculture we can envisage at the moment will feed 9 billion people at a time of rapid climate change, and decreased fossil fuel availability. GM crops probably have a part to play in mitigating the problems we face this century, but they are certainly not the whole answer.

[8] International assessment of agricultural knowledge, science and technology for development (IAASTD): synthesis report with executive summary: a synthesis of the global and sub-global IAASTD reports edited by Beverly D. McIntyre et al. (2009) p45.