House of Commons

Science and Technology Committee

Advanced genetic techniques for crop improvement: regulation, risk and precaution

Fifth Report of Session 2014–15

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Science and Technology Committee

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Summary

To meet the huge challenge of feeding a burgeoning global population, using fewer resources, in what is likely to be an increasingly difficult climate, it is likely that we will need to use all of the tools at our disposal, be they social, political, economic or technological.

The use of advanced genetic techniques to enhance the quality, yield and resilience of agricultural crops is one such tool. Staple crops, genetically modified for the purpose of improved pest control, have been widely cultivated for over twenty years and evidence suggests that they have delivered significant benefits, increasing crop yields while reducing the need for harmful pesticides. A much broader array of potential products are in the pipeline, which make use of a variety of advanced techniques to produce novel crop varieties. No single crop offers a panacea to global agricultural problems but, together, novel crops could play an important role in helping tomorrow's farmers to produce more from less.

The EU's current regulatory regime for genetically modified organisms (GMOs) threatens to prevent such products from reaching the market, both in the UK, in Europe and, as a result of trade issues, potentially in the developing world. We identified three major flaws in this regime.

Firstly, the focus of the current regulatory system on GMOs is based on the assumption that genetically modified crops inherently pose greater risk than crops produced using other techniques. This fails to leads to a failure to recognise that the risk posed by a crop has little to do with how it is made and is mostly to do with the characteristics it displays and how it is used in the field. Such 'process-based' regulation also fails to keep pace with technology and therefore potentially acts as a block on innovation. Secondly, the current system assesses the risks posed by these products but fails to take account of their potentially significant benefits, to the producer, the consumer and, increasingly, the environment. Finally, and perhaps most significantly, it fails to observe the principle of subsidiarity, preventing member states from making their own decisions about whether or not to adopt a suite of products about which deep political divisions exist across the EU. This forces those member states opposed to genetic modification on political grounds to dispute the science, exaggerating uncertainty and misrepresenting the precautionary principle in an attempt to delay or prevent EU-wide authorisation. As a result, applications remain trapped in the system for years, or even decades.

A recent amendment to EU GMO legislation, strongly pressed for by the Government, should oil the political wheels and potentially break the stalemate. But it does not go far enough in ensuring that member states may access GMOs that have passed the risk assessment process. That is why we recommend that the Government make a long-term commitment to achieving more substantial regulatory overhaul and a more meaningful repatriation of national decision-making. We also target several recommendations at the European Commission and hope to receive a formal response through the EU political dialogue process.

Scientific evidence is a vital input to decision-making about new technologies but, as the situation in Europe demonstrates, value-based considerations also play an important role. In the UK, the Government's world-leading science advisory structure ensures that it is well informed about the former, but much less so about the latter.

There is a need to reframe and widen what has been a debate about 'GM', in order to initiate a new, more constructive conversation about what we want from food and agriculture. Only from that can we establish what role we would like advanced crop breeding approaches to play. We recommend a large scale public dialogue on the future of food and farming and a shift in the Government's own frames of reference regarding these technologies. We also recommend that the Government clarify its own thinking about the precautionary principle, so that it can act as a better guide to policy making.

While Government needs to play a more significant role in informing the public about GM, it will never be the first port of call for many people. Other sources, including the media and non-governmental organisations, have a responsibility to provide accurate information, whatever their ideological slant. We urge those with a view about GM to be honest about the reasons for those views and not cloak value-based opposition in scientific terms.

This is not the first time we, as a Committee, have encountered a failure of Government to lead the debate about emerging issues in science and technology. We recommend that the Government develop an information hub with the National Academies as a starting point for the public debate. This should link to debates led by Sciencewise whose function the Government must continue to support. Finally, we recommend the establishment of a permanent citizens council, based on the model used by NICE, to help it understand the potential social and ethical impacts of developments in novel crop technologies

1 Introduction

Background

1. For millennia, humans have been modifying plant genomes in order to create crops that are better suited to our agricultural needs.[1] Every time we choose to breed from the 'best'—the tallest, strongest, tastiest, most disease-resistant—plants, we usurp natural selection, exerting our own influence over the evolutionary process in order to increase the frequency of those traits that we desire.[2] Current agricultural yields are testament to the success of these methods. However, according to the Royal Society, "even the most optimistic scenarios require increases in food production of at least 50%" if the world is to feed a predicted population of 9 billion by 2050, and this will have to be achieved with less land, less water and less energy if productivity gains are to be sustainable.[3] This is an urgent and formidable challenge. It is also a complex one, comprising many social, political and economic issues that few would argue can be solved by technology alone. Nevertheless, as the Government has emphasised, technology has a part to play in securing global food security and genetic approaches to crop breeding may offer one potential aspect of this technological solution.[4]

2. Over the last 20 years, the term 'GM' has become shorthand for a range of technologies that allow us to add to, subtract from, or in some other way modify an organism's genetic material in order to alter existing traits or introduce new ones.[5] Like any deliberate or intuitive breeding method, these technologies use genetic science to supplant natural selection, but do so with more control, greater precision and improved reliability, opening up a broader spectrum of possibilities.[6] In 2013, 18 million farmers in 27 different countries grew genetically modified crops over a total of 175 million hectares—more than 12% of the world's arable land.[7]

3. Scientific evidence supporting the safety of genetically modified crops, in respect of both human and animal health and the environment, is very strong: in 2010, a report by the European Commission looking back on 130 EU-funded research projects, covering a period of more than 25 years and involving more than 500 independent research groups, concluded that genetically modified organisms (GMOs) were "not, per se, more risky than […] conventional plant breeding technologies".[8] However, GMOs remain subject to

1 For a history of plant breeding, see: Noel Kingsbury, *Hybrid: The history and science of plant breeding*, (Chicago, 2009), pp.20-35. See also Nuffield Council on Bioethics, *Genetically modified crops: the ethical and social issues*, May 1999, paras 2.1-2.2

2 A trait is 'any detectable phenotypic property of an organism'; that is, its observable characteristics. Traits might include size, colour, leaf shape, or less obvious characteristics such as ability to withstand drought or attack by a particular pest. See Michael Allaby (ed.), *A Dictionary of Plant Science*, 3rd edition, 2012, Oxford Reference Online.

3 The Royal Society, *Reaping the benefits*, October 2009, p.1. See also Q445 [George Freeman MP]

4 HM Government, *Our policy on genetically modified organisms*, accessed 8 December 2014

5 Based on: Richard Cammack et al (eds.), *Oxford Dictionary of Biochemistry and Molecular Biology*, 'Genetically modified organism', 2nd edition, 2008, Oxford Reference Online, accessed 26 January 2015.

6 See, for example, Q9 and Q35 [Professor Baulcombe]

7 GMC051 [Gov] para 14

8 European Commission, Directorate-General for Research, *A decade of EU-funded GMO research*, 2010, p.18.

stringent regulation under an EU legislative framework which has been influenced by the inappropriate application of the precautionary principle[9]—an approach intended to guard the environment from irreparable harm in conditions of scientific uncertainty.[10] Since a framework was first developed in 1990, only two genetically modified crops have achieved authorisation for cultivation, leading to what is effectively a moratorium on the technology across Europe.[11] The difference between the EU's position regarding these products and that of the US Government has led to disputes at the World Trade Organisation and is likely to be a factor in the ongoing Transatlantic Trade Investment Partnership negotiations.[12]

4. We decided to conduct an inquiry to better understand the reasons for this situation in the hope of offering recommendations for its resolution. We also hoped to elucidate, through a detailed examination of the case of genetic modification, lessons which could be applied to the future governance of other fields of emerging technology.

Our inquiry

5. In February 2014, we issued a call for evidence addressing the following issues:[13]

- Are current EU and UK regulations intended to assess the safety of genetically modified (GM) foods fit for purpose? If not, why not?
- How have EU and UK regulations on GM foods affected the UK's international competitiveness?
- Does the current EU and UK regulatory framework allow for GM foods to effectively contribute to the delivery of the UK Agricultural Technologies Strategy? If not, why not?
- What are the particular barriers to the conduct of research on GM foods in the UK?
- Is the EU's application of the precautionary principle in relation to GM foods appropriate? Does the EU recognise and handle properly the concepts of hazard and risk?

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9 See paragraphs 97-103.

10 For example, Directive 2001/18/EC on the deliberate release into the environment of genetically modified organisms, stipulates that both risk management and environmental risk assessment of GMOs should be carried out "in accordance with the precautionary principle". See article 4 and annex II. For a working definition of the precautionary principle see: United Nations Educational, Scientific and Cultural Organization, World Commission on the Ethics of Scientific Knowledge and Technology, *The Precautionary Principle*, March 2005, p.14

11 The two products to have gained authorisation for cultivation are a genetically modified insect-resistant maize (MON810), which was authorised in 1998 and is currently cultivated in five EU member states, and a genetically modified high-starch industrial-use potato ('Amflora') which was authorised in 2010 and withdrawn from the market in 2011. See European Commission, 'New EU approach: fast facts', ec.europa.eu, accessed 20 January 2015.

12 House of Commons Library, 'The Transatlantic Trade and Investment Partnership (TTIP)', Standard Note SN/EP/6688, 13 January 2015, pp.10-11

13 Science and Technology Committee, 'GM foods and application of the precautionary principle in Europe: Terms of reference', press release, 14 February 2014, accessed 26 January 2015.

- Are there other examples of EU regulation in which the precautionary principle has not been applied appropriately?

6. During the inquiry, we received over 60 written submissions and took oral evidence from over 30 witnesses, including:

- Supporters and opponents of advanced genetic approaches to crop breeding;
- Consumer, farming and industry representatives;
- Experts in public dialogue, science policy and risk regulation;
- The European Commission and the European Food Safety Authority;
- Relevant scientific advisory bodies and the Government's Chief Scientific Adviser, Professor Sir Mark Walport, and
- The Government, represented by Lord de Mauley, Parliamentary Under Secretary of State for Natural Environment and Science (hereafter "the Minister") and George Freeman MP, Parliamentary Under Secretary of State for Life Sciences.

We would like to thank all of those who contributed to this inquiry.

7. Given our intended focus on the EU regulatory system, we have adopted terms similar to those used in current legislation. Our terms of reference were focused largely on genetically modified organisms; specifically, genetically modified foods. We appreciate, however, that 'genetic modification', as currently defined by the EU, is just one of many advanced genetic techniques and that this entire field is just one of many potential trajectories in agricultural innovation. Chapter 2 therefore provides a brief overview of current approaches and applications of both conventional and advanced genetic techniques for crop improvement. Chapter 3 summarises current UK policy on genetically modified crops and considers the potential role of advanced genetic technologies in global agriculture, exploring arguments that the use of such technologies 'locks out' alternative approaches. Chapter 4 examines in depth the EU regulatory environment for genetically modified organisms and chapter 5 draws on the findings of the previous chapter to consider in more general terms how best to govern risk under varying states of incertitude. Finally, chapter 6 considers the role of public information and discourse in shaping policy on contentious topics in science and technology and explores the need for a wider public debate on the future of food and agriculture.

2 Genetic crop improvement: approaches and applications

Genetic crop improvement

8. Genetic crop improvement, in its broadest sense, can be defined as any process through which the genetic make-up of a plant variety or species is deliberately altered in order to increase the frequency of beneficial traits.[14] In this sense, most modern crops can be considered to be genetically improved. The intuitive use of selective breeding pre-dates our understanding of genetics and coveted traits originating in different species have also long been combined, often via artificial means such as grafting, through the process of hybridization. More recently, when breeders have wanted to increase the range of 'natural' variation available to select from, radiation has been used as a tool for doing so.[15] Such techniques were once considered cutting-edge and played an important part in the 'green revolution', during which agricultural yields increased by orders of magnitude, saving millions from starvation and drastically changing the nature of global agriculture in the process.[16] Today, however, they are more often classified as 'conventional breeding techniques', set in contrast to the 'advanced' methods that form the main subject of this report.[17]

Advanced genetic techniques

9. Genetic modification ('GM') is the term commonly used to describe a range of techniques through which plant breeders can add to, subtract from, or in some other way make more precise modifications to an organism's genetic material in order to alter existing traits or introduce new ones.[18] For decades, genetic modification has been widely used in research, medicine and other applications (see box 1) and the first genetically modified food—a tomato puree, made using the 'Flavr Savr' delayed-ripening GM tomato—was launched over 20 years ago, in 1994.[19] Since then, crops produced using genetic modification have been produced and consumed in many countries, including the US, Brazil, Argentina, Canada, India, South Africa and Spain.[20] According to the so-called 'Baulcombe report', prepared in 2014 for the Prime Minister's Council for Science and

14 This definition derives from a 2014 position statement issued by the Biotechnology and Biological Sciences Research Council (BBSRC). This used the term 'genetic crop improvement' to describe a range of methods that relied on "introducing genetic changes" in order to "add beneficial characteristics or remove undesirable ones". See Biotechnology and Biological Sciences Research Council, New techniques for genetic crop improvement: position statement, September 2014, accessed 26 January 2015.

15 Noel Kingsbury, *Hybrid: The history and science of plant breeding*, (Chicago, 2009), pp.163-165; pp.267-268.

16 Noel Kingsbury, *Hybrid: The history and science of plant breeding*, (Chicago, 2009), pp.285-328

17 For an example of this type of distinction, see Nuffield Council on Bioethics, *Genetically modified crops: the ethical and social issues*, May 1999, chapter 2.

18 Based on: Richard Cammack et al (eds.), *Oxford Dictionary of Biochemistry and Molecular Biology*, 'Genetically modified organism', 2nd edition, 2008, Oxford Reference Online, accessed 26 January 2015.

19 GMC055 [IGD]

20 David Baulcombe, Jim Dunwell, Jonathan Jones, John Pickett and Pere Puigdomenech, *GM science update: a report to the Council for Science and Technology*, March 2014, p.9

Technology, 81% of the global acreage of both soybean and cotton is currently sown to genetically modified varieties and the global acreage under all forms of GM is currently doubling every five years.[21] This amounts to 175 million hectares in total, less than 1% of which is grown in the EU.[22] However, Europe is by no means GM-free. The EU has approved more than 40 genetically modified products for import—mostly cotton, soybean and maize—and, according to the Society of Biology, "more than 70%" of the EU's protein-based animal feed is genetically modified.[23]

Box 1: Other uses of advanced genetic approaches

Advanced genetic approaches have been widely used in science and industry for many years. Common applications of genetically modified organisms include:

- **Research.** In 2013, over 2 million genetically modified (GM) animals—largely mice, rats and fish—were bred for research purposes.[24] These are used primarily in medical research, where they aid understanding of gene function and act as models for human disease. GM plants are also an important laboratory tool.[25]

- **Medicine**. In 1982, insulin derived from modified bacteria became the first genetically engineered product to obtain approval from the US Food and Drug Administration.[26] Other therapeutic proteins, such as human growth hormone, are also now produced using GM organisms and GM plants have recently emerged as a low-cost alternative to current techniques used to produce protein-based pharmaceuticals and vaccines (this practice is known as "pharming").[27]

- **Cheese production**. Since the late 1980s, GM yeast has been used to produce an enzyme called chymosin. Traditionally sourced from calf stomach, chymosin, or 'rennet', is a key ingredient in the cheese-making process. Today, about 90% of the hard cheese in the UK is made using chymosin from modified microbes.[28]

- **Environmental management**. GM bacteria can be used for both the production of biodegradable plastics and for bioremediation—the use of microorganisms to remove

21 David Baulcombe, Jim Dunwell, Jonathan Jones, John Pickett and Pere Puigdomenech, *GM science update: a report to the Council for Science and Technology*, March 2014, p.1

22 In the EU, only one GM product is currently grown commercially: an insect resistant variety of GM maize, approximately 100,000 hectares of which is grown in Spain. This accounts for around 30% of Spain's total maize production. GMC029 [SCIMAC] para 34

23 GMC046 [Society of Biology] para 4

24 Home Office, *Annual Statistics of Scientific Procedures on Living Animals: Great Britain 2013*, HC 372, 10 July 2014, p 17.

25 Biotechnology and Biological Sciences Research Council, correspondence to Andrew Miller MP, parliament.uk, April 2014.

26 US FDA, *Celebrating a Milestone: FDA's Approval of First Genetically-Engineered Product*, 2007, accessed 8 December 2014.

27 Parliamentary Office of Science and Technology, *Plant-made pharmaceuticals*, POSTnote 424, December 2012.

28 University of Reading, National Centre for Biotechnology Education, *Case studies: chymosin*, accessed 8 December 2014.

or neutralize damaging pollutants. Several GM organisms, including plants, yeast and algae, have also been considered for use in biofuel production.[29]

10. This global market is currently dominated by a relatively small number of products which might be referred to as the 'first generation' of genetically advanced crops.

'First generation' products and techniques

11. The 'first generation' of genetically modified products are largely transgenic: that is, they contain genetic material that originated in an organism of a different species. A variety of techniques have now been developed through which genetic material can be inserted into a target plant, but, initially, first generation methods usually led to the insertion being made at a random location in the plant genome.[30] Multiple generations of the modified crop were then grown to ensure that the gene has been properly inserted and in order to screen for any unexpected consequences.[31] First generation products typically contain one (or both) of two trait types, both of which are intended to help reduce agricultural losses from pests:

i) **Insect resistance**. Bt toxin is an insecticidal chemical produced by a soil bacterium called *Bacillus thuringiensis*. It is poisonous to a wide range of crop pests, and chemical preparations containing Bt have been used as insecticides since the 1930s.[32] In the mid-1980s, the agricultural biotechnology industry began using advanced genetic techniques to insert the gene responsible for Bt's toxicity directly into the crop genome, seeking to confer resistance directly onto the crop and reduce the need for repeated insecticide spraying.[33] Bt-based insect-resistant crops are now produced by several companies, including Syngenta, Monsanto and Dow AgroSciences.[34]

ii) **Herbicide tolerance**. Herbicides are chemicals used to kill unwanted plants. They are a special case among crop protection products because the target (the weed) and the protected crop are both plants; the challenge is to kill the weed but not the crop.[35] Advanced genetic techniques have been used to facilitate this by inserting genes that confer herbicide resistance into the crop genome, making the crop plant impervious to herbicidal spraying. Several different types of resistance have been developed using first generation techniques, the most common being tolerance to glyphosate, a widely used herbicide.[36] The most well-known collection of herbicide

29 See, for example, Parliamentary Office of Science and Technology, *Biofuels from algae*, POSTnote 384, July 2011.

30 Nuffield Council on Bioethics, *Genetically modified crops: the ethical and social issues*, May 1999, para 2.7.

31 This type of insertion technique is described at: Food Standards Agency, 'GM basics: how does genetic modification work?', food.gov.uk, accessed 26 January 2015. See also Q15 [Dr Parr]

32 The Royal Society, *Reaping the benefits*, October 2009, case study 3.1, p.23

33 The Royal Society, *Reaping the benefits*, October 2009, case study 3.1, p.23

34 See the EU register of authorised GMOs, ec.europe.au, accessed 26 January 2015.

35 The Royal Society, *Reaping the benefits*, October 2009, p.30

36 The Royal Society, *Reaping the benefits*, October 2009, p.30

resistant crops are Monsanto's 'Roundup ready' products, so-named because of their tolerance to the company's popular glyphosate-based weed-killer, Roundup.

12. Evidence suggests that, like any product, insect-resistant and herbicide-tolerant crops carry potential risks as well as benefits. Constant exposure of insect pests to the Bt toxin could lead to accelerated development of resistance, reducing Bt's effectiveness over time, although evidence about whether or not this has occurred is mixed.[37] Similarly, repeated exposure of weeds to large amounts of herbicide could lead to the rapid evolution of so-called "superweeds"; a process that might be accelerated if farmers use a single herbicide more liberally as a result of growing herbicide-tolerant crops.[38] There is some evidence to suggest that crops containing Bt toxin may also pose a threat to non-target insects, such as butterflies.[39] The Royal Society argued that "where risks have been identified, for example in the case of herbicide tolerance, they relate to the trait that has been introduced rather than the method by which it was introduced".[40] It added that such effects were often the lesser of two evils, as, for example, "control of insect pests with insecticides poses a greater risk of damage to non-target organisms than control with transgenic Bt protein".[41]

13. Overall, the balance of scientific evidence, as measured by peer-reviewed scientific publications, suggests that first generation products have been effective in increasing crop yield and reducing pesticide use. A recent peer-reviewed meta-analysis of "the agronomic and economic impacts of GM crops", which looked at a total of 147 studies, found that, on average, use of these products had "reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%".[42] Yield gains and pesticide reductions were found to be larger for insect-resistant crops than for herbicide-tolerant crops, and were higher in developing countries than in developed countries.[43] Research by the US Department of Agriculture found that adoption of first generation genetically modified

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37 GMC041 [Wildlife and Countryside Link] para 4.4. According to the US Department of Agriculture, "so far, the emergence of insect resistance to Bt crops has been low and of 'little economic and agronomic significance', but there are some indications that insect resistance is developing to some Bt traits in some areas". US Department of Agriculture Economic Research Service, *Genetically Engineered Crops in the United States*, Economic Research Report Number 162. February 2014, pp.29-31.

38 The Royal Society, *Reaping the benefits*, October 2009, p.30. See also GMC024 [Mr Kevin R Coleman] para 12; GMC018 [Dr Richard Weightman] para 8; Q21 [Ms O'Neill]; Q117 [Mr Melchett]; US Department of Agriculture Economic Research Service, *Genetically Engineered Crops in the United States*, Economic Research Report Number 162. February 2014, pp.31-33.

39 Q337 [Professor Perry]; Q21 [Ms O'Neill]. Note, according to the Royal Society: "Some laboratory tests seemed to indicate that the pollen of Bt maize presents a threat to monarch butterflies. However, further studies showed that Bt maize pollen did not in fact pose a threat as the density of pollen on the milkweed leaves on which monarch caterpillars feed is much lower than that which would cause harm". The Royal Society, *Reaping the benefits*, October 2009, case study 3.1, p.23

40 GMC044 [Royal Society] para21. See also Q22 [Professor Leyser]; GMC037 [Agriculture and Horticulture Development Board] para 9

41 The Royal Society, *Reaping the benefits*, October 2009, p.23, p.30. The US Department of Agriculture similarly stated that glyphosate, "the most heavily used pesticide in the United States since 2001", in part because of high take-up of genetically modified glyphosate-resistant crops, "is more environmentally benign than the herbicides that it replaces". US Department of Agriculture Economic Research Service, *Genetically Engineered Crops in the United States*, Economic Research Report Number 162. February 2014, p.31.

42 Wilhelm Klümper and Matin Qaim, "A Meta-Analysis of the Impacts of Genetically Modified Crops", *PLOSOne*, November 3 2014. DOI: 10.1371/journal.pone.0111629.

43 Wilhelm Klümper and Matin Qaim, "A Meta-Analysis of the Impacts of Genetically Modified Crops", *PLOSOne*, November 3 2014. DOI: 10.1371/journal.pone.0111629.

products in the US had correlated with a decrease in pesticide use[44] and a reduction in "the carbon footprint of agriculture".[45] The relative risks posed by genetically modified versus conventionally bred crops are discussed further in chapter 4.

'Second generation' products and techniques

14. There was some disagreement about whether or not the field of advanced crop breeding had moved on since this first generation of products was developed. Dr Doug Parr, Chief Scientist and Policy Director at Greenpeace UK, stated that things had "not changed an awful lot" over the last 20 years and Liz O'Neill, Director of the advocacy group GM Freeze, pointed out that "the crops that are currently awaiting approval in the EU are all herbicide tolerant and insecticide expressing"—in other words, they are first generation products.[46] However, Professor Sir David Baulcombe, University of Cambridge, argued that things had "moved on enormously" during this time period and claimed that "to say that things have not moved on […] is a complete travesty. It is totally wrong".[47] He explained that scientists now possessed far more genomic data and "a much more sophisticated understanding" of plant genetics, meaning that the potential to develop new technologies was now "enormous".[48]

15. The Science Council[49] agreed that a "second generation" of genetically advanced crops, displaying a wider range of traits and with much broader potential applications, had started to emerge.[50] A detailed list of traits currently "in the pipeline" was set out in the 2014 Baulcombe report[51] and, according to the Government, include:

> various forms of disease resistance (e.g. blight-resistant potatoes), various forms of abiotic-stress tolerance (e.g. drought-tolerance), nitrogen-use efficiency (i.e. enabling less use of artificial fertiliser), other forms of pest resistance (e.g. against nematodes and aphids), and crops with improved nutritional characteristics (e.g. 'golden rice', to combat vitamin A deficiency, plants that produce healthy omega-3 oils and purple tomatoes with beneficial antioxidants).[52]

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44 The report concluded that while "insecticide use decreases with the adoption of Bt [insect resistant] crops", adoption of herbicide-tolerant [HT] crops had a "mixed but relatively minor effect" on herbicide usage. It added that "the main effect of HT crop adoption on herbicide use is the substitution of glyphosate for more toxic herbicides", leading to "an improvement in environmental quality and a reduction in the health risks associated with herbicide use". See US Department of Agriculture Economic Research Service, *Genetically Engineered Crops in the United States*, Economic Research Report Number 162. February 2014, pp.23-26.

45 US Department of Agriculture Economic Research Service, *Genetically Engineered Crops in the United States*, Economic Research Report Number 162. February 2014, pp.26-27.

46 Q4 [Dr Parr]; Q26 [Ms O'Neill]

47 Q35

48 Q35

49 The Science Council is an umbrella organisation representing 41 UK learned societies and professional bodies.

50 GMC047 [Science Council] para 2.4. See also GMC009 [James Hutton Institute] para 2 for use of this terminology.

51 David Baulcombe, Jim Dunwell, Jonathan Jones, John Pickett and Pere Puigdomenech, *GM science update: a report to the Council for Science and Technology*, March 2014, pp.16-19. These included enhanced photosynthesis, stress tolerance, aluminium tolerance, salinity tolerance, pest and disease resistance, nitrogen and phosphorus use efficiency and nitrogen fixing.

52 GMC051 [Gov] para 15

Many of these traits are designed to provide consumer and environmental benefits as well as the productivity gains targeted by first generation products. Nutritionally-enhanced 'golden rice', for example, is designed to combat vitamin A deficiency and, according to the Science Council, use of GM technology in the development of an anti-malarial vaccine was further evidence of these techniques "being used for the benefit of society".[53] Much of this emerging research is being conducted in the UK (see box 2).

Box 2: Genetically improved products currently under development in the UK

UK-based research has led to several potential innovations in the field of advanced genetic crop improvement. These include the following:

- **Blight-resistant potatoes**. Potato blight is a rotting disease caused by a fungus-like organism called *Phytophthora infestans*. It was one of the major causes of the Irish potato famine and, according to the Government, costs UK farmers around £60 million each year to control through fungicidal spraying.[54] Scientists at the Sainsbury Laboratory in Norwich have used advanced genetic techniques to introduce a blight-resistance gene, common to a South American wild relative of the potato, into the popular Desiree variety in order to increase its resistance to this disease (similar work has been carried out by both BASF and Syngenta). During a period of "perfect 'blight weather'" in a recent field trial, all of the non-modified potatoes became infected with the disease, while all of the modified potatoes remained blight-free.[55]
- **Anthocyanin-enriched tomatoes**. Researchers at the John Innes Institute have genetically engineered tomatoes to increase their production of anthocyanin, a natural tomato pigment. According to recent peer-reviewed research, the resulting 'purple' tomatoes demonstrated "significantly" extended shelf life, were less susceptible to a common mould and showed "increased antioxidant capacity".[56] Mice fed with high-anthocyanin tomatoes also showed a significant (30%) extension of life span.[57]
- **Omega-3 oil producing plants.** Omega-3 oil is an essential fatty acid found in fish. In the wild, fish source omega-3 oil through the various algae and plankton that they consume; however, farmed fish do not have access to these dietary sources and therefore have to be fed with food artificially enriched with omega-3. This is itself sourced from wild fish populations, leading to an unsustainable depletion of fish stocks.[58] Scientists at Rothamsted Research have found a way to more sustainably produce omega-3 oils for use in fish food by inserting a genetic sequence usually found in plankton into Camelina plants, enabling the plants to accumulate omega-3 oil in their seeds.[59] A trial designed to test the effectiveness of these plants under 'real-life' conditions is currently underway.

53 GMC047 [Science Council] para 2.5

54 GMC051 [Gov] para 12; Jim Donnelly, *The Irish Famine*, BBC History, February 2011, accessed 9 December 2014.

55 Jonathan D. G. Jones, Kamil Witek, Walter Verweij, Florian Jupe et al, *Elevating crop disease resistance with cloned genes, Philosophical Transactions of the Royal Society B,* vol 370 (2014) DOI: 10.1098/rstb.2013.0087

56 Yang Zhang, Eugenio Butelli, Rosalba De Stefano, Henk-jan Schoonbeek. et al, *Anthocyanins Double the Shelf Life of Tomatoes by Delaying Overripening and Reducing Susceptibility to Gray Mold*, *Current Biology*, vol 23 (2013) DOI:10.1016/j.cub.2013.04.072

57 Eugenio Butelli, Lucilla Titta, Marco Giorgio, Hans-Peter Mock et al, *Enrichment of tomato fruit with health-promoting anthocyanins by expression of select transcription factors*, *Nature Biotechnology,* vol 26 (2008). DOI.10.1038/nbt.1506.

58 GMC015 [Sense about Science] Appendix 1

59 Rothamsted Research, *Questions and answers*, accessed 9 December 2014.

16. While first generation products were typically transgenic and involved genetic material being randomly inserted into the plant genome, second generation products are increasingly using more subtle and precise techniques. These include:

- cisgenic modification, in which the inserted gene is derived from the same species as the target plant (for example, as in the blight-resistant potatoes described in box 2);
- genome editing, through which insertions, deletions and other modifications—sometimes of extremely short sections of DNA—can be targeted at specific sites in the plant genome, and
- epigenetic modification, through which specific genes can be selectively 'silenced' without directly changing the underlying genetic sequence.[60]

According to Professor Rosemary Hails, Chair of the Advisory Committee on Releases to the Environment, unlike first generation techniques, "these new techniques are about moving genes between species that are sexually compatible, altering the configuration or even just making a point change".[61] She added: "they have filled in all of the grey space between conventional breeding and recombinant DNA technology".[62] Professor David Baulcombe, University of Cambridge, explained that advances in genome sequencing technology also meant that it was now "relatively easy to characterize the complete genome sequence and the transgene insertion sites in the recipient genome", further reducing uncertainty about the potential impact of the process.[63]

Terminology

17. A recurring theme of this inquiry has been the importance of terminology and the inadequacy of the shorthand term 'GM' as a label for the various techniques and applications described above. As Professor Sir Mark Walport, the Government Chief Scientific Adviser, recognised, this overly simple terminology encourages us to "talk about this as though it was a generic technology, which we should not do".[64] He explained:

> Whether GM technology is a good or bad thing is not a sensible question; it depends on how it is applied. The question in every case is: what gene, what organism and for what purpose?[65]

Under EU legislation, a genetically modified organism is any organism, "with the exception of human beings, in which the genetic material has been altered in a way that does not

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60 Further information on these techniques is available at: Biotechnology and Biological Sciences Research Council, New techniques for genetic crop improvement: position statement, September 2014; Advisory Committee on Releases to the Environment, *ACRE advice: New techniques used in plant breeding*, July 2014.

61 Q427

62 Q427

63 GMC027 [Professor Baulcombe] para 8

64 Q273

65 Q273

occur naturally by mating and/or natural recombination".[66] This broad definition could be considered to include some of the emerging techniques described above; however, the term 'GM' was coined at a time when transgenic insertion was the dominant technique and insect and herbicide resistance were the dominant traits. The term is therefore closely associated with these first generation products.

18. **The term genetic modification, or GM, is most commonly used to describe a transgenic process in which a gene from one organism is inserted, often at random, into the genome of another organism of a different species. This fails to accurately portray the wide range of techniques through which targeted genetic changes can now be introduced into crops, which include same species cisgenic transfers, precise point changes to the plant genome and epigenetic modifications that do not alter the underlying genetic sequence. In our view, it is time to update this imprecise and problematic terminology.**

19. **We recognise that the term GM has become embedded in everyday language and is now often used imprecisely to encompass a whole range of technologies. In this report—except when quoting from evidence or using legally significant terminology—we will attempt to avoid using the term 'GM' and will use the phrase 'genetic modification' only when referring specifically to the first generation transgenic techniques to which it has historically been applied. We will avoid this terminology when referring more broadly to the full range of advanced genetic techniques currently in development. *We recommend that the Government initiate a reframing of the public conversation by similarly moving away from the overly simple notion of 'GM' in its own policies and communications.*** This matter is discussed further in chapter 6.

[66] Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms, article 2 (2)

3 The role of advanced genetic techniques in agricultural innovation

National policy on the use of advanced genetic techniques

UK policy

20. The Government has clearly stated its support for the use of advanced genetic techniques in crop improvement. In a widely reported speech to the National Farmers' Union in February 2013, Owen Patterson MP, then Secretary of State for the Environment, Food and Rural Affairs, stated that the world was "ploughing ahead and reaping the benefits" of this field of technology and that the Government "must address the paralysis" in the EU regulatory system if Europe was to avoid "being left behind".[67] Mr Patterson's replacement as Secretary of State, Elizabeth Truss MP, has also recently indicated her support, reportedly stating that "GM crops have a role to play here in Britain" and calling on the EU to take a more evidence-based approach to decision-making with regard to cultivation.[68] In an online summary of its policy in this area, the Department for Environment, Food and Rural Affairs states that "the protection of human health and the environment are our overriding priorities", but that:

> GM technology could deliver benefits providing it is used safely and responsibly, in particular as one of a range of tools to address the longer term challenges of global food security, climate change, and the need for more sustainable agricultural production.[69]

21. The Government told us that it was "concerned" that there was "a significant opportunity cost" associated with the UK "not embracing this technology", which risked "putting us at a major competitive disadvantage" in the global agricultural market.[70] It estimated that "adopting GM maize, rape and beet varieties could increase UK farm profits by between £28m and £48m annually" and suggested that "if there were a properly functioning EU regime it is possible that one or more of such crops might already be being grown here".[71]

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67 Department for Environment, Food and Rural Affairs, *Owen Patterson speech at the National Farmers Union Annual Conference 2013*, published 27 February 2013, accessed 26 January 2015.

68 Department for Environment, Food and Rural Affairs, *Environment Secretary speech at the Oxford farming conference*, published 7 January 2015, accessed 26 January 2015; "Britain must be free to grow GM food, says Minister", *The Times*, 8 January 2015, accessed 26 January 2015.

69 Department for Environment, Food and Rural Affairs, 'Policy: Making the food and farming industry more competitive while protecting the environment', *Detail: genetic modification*, gov.uk, last updated 14 November 2014, accessed 26 January 2015.

70 GMC051 [Gov] para 16

71 GMC051 [Gov] para 12

Devolved policy

22. The Government told us that "GM policy" was "devolved within the UK, and therefore Wales, Scotland and Northern Ireland are responsible for issues relating to the release of GM crops in their own territory".[72] The policies of the devolved nations are at significant variance with that of the UK Government. Aileen McLeod MSP, Scotland's Minister for Environment, Climate Change and Land Reform, told us that the Scottish Government was "fundamentally opposed to the cultivation of GM crops in Scotland".[73] In explaining this position, Ms McLeod pointed out that Scotland's food and drink sector depended "to a large extent on the public's perception of our clean and green image", which she stated "could be adversely affected by growing GM crops in Scotland".[74] She also implied that this position had a scientific basis, as there was "still some debate about the long term effects on the environment from growing GM crops".[75] Mark Durkan MLA, Northern Ireland's Minister of the Environment, stated that he was also "opposed in principle" to the growing of genetically modified crops and "welcomed" the EU's proposal to allow countries to prohibit cultivation in their own territories on grounds other than safety (see paragraphs 83-87).[76] Rebecca Evans AM, Wales' Deputy Minister for Farming and Food, told us that the Welsh Government also took a "restrictive and precautionary approach to GM crop cultivation" because of the need to protect its food and drink sector.[77] However, Ms Evans added that she believed in "keeping an open mind on future GM developments and more advanced genetic techniques" and "would be supportive of new research" into the field.[78]

23. Ms McLeod's claim that there is still some debate about the long term effects of cultivating genetically modified crops does not appear to be supported by the available scientific evidence. The European Academies Science Advisory Council (EASAC), the umbrella organisation for the national science academies of the EU's 28 member states, notes that, after over fifteen years of cultivation, there is "no compelling evidence" that genetically modified crops pose greater risk to humans, animals or the environment than that associated with conventional crops.[79] Given this long history of safe use, the Prime Minister's Council for Science and Technology recently advised that "we should have confidence in the consensus on the scientific evidence which concludes that, when properly controlled, GM products are as safe as their conventional counterparts".[80]

24. **This Committee does not scrutinise the policies of the Devolved Administrations but we hope that they note the observations of this report and understand that foods, most especially animal feeds, increasingly contain elements of genetically modified crops despite their inclination not to permit the growth of such crops.**

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72 GMC051 [Gov] para 1

73 GMC062 [Scottish Gov Supp]

74 GMC062 [Scottish Gov Supp] para 1

75 GMC062 [Scottish Gov Supp] para 1

76 GMC061 [NI Gov]

77 GMC060 [Welsh Gov]

78 GMC060 [Welsh Gov]

79 European Academies Science Advisory Council, *Planting the future: non-technical summary*, June 2013, pp.4-5

80 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015.

25. **While recognising that agricultural policy is a devolved area and respecting the right of the Devolved Administrations to maintain a restrictive approach to the use of advanced genetic crop breeding techniques, we reject the Scottish Government's suggestion that this policy has a scientific basis.** ***We encourage all of the Devolved Administrations to take an evidence-based approach to policy on the use of advanced genetic approaches to crop improvement. Where policies are based on other considerations, this should be made clear: allegations of scientific uncertainty should not be used as a pretence for value-based objections.***

The global potential of advanced genetic techniques

26. The Government described genetic modification as one of "a range of tools" that could be used to tackle today's global agricultural challenges.[81] However, not all of our witnesses agreed that this was a tool that should be utilised. Dr Doug Parr, Greenpeace UK, stated that Greenpeace saw "no case" for cultivating genetically modified crops, although it was "perfectly happy" with applications that involved genetically modified organisms being used in a contained environment (for example, in commercial insulin production) and supported other forms of biotechnology, such as marker assisted selection (see box 3).[82] Liz O'Neill, GM Freeze, called for a "moratorium" on the cultivation and import of genetically modified foods and feedstuffs and stated that her organisation "would have difficulty imagining" how first generation products "could be used in a positive way".[83] In contrast, EASAC stated that "GM technology […] must be allowed to take its place among the scientific advances that European plant breeders and farmers can call upon" and argued that, given the magnitude of the agricultural challenges the world is currently facing, "no new technology should be excluded on purely ideological grounds".[84] A 2011 report prepared by the Government's Foresight Unit similarly concluded that new technologies such as advanced genetic techniques "should not be excluded *a priori* on ethical or moral grounds, though there is a need to respect the views of people who take a contrary view".[85]

27. **We do respect that people have every right to such views but restate our earlier observation that those views on ethical or moral grounds should not imply or claim that those objections have any basis in scientific evidence.**

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81 Department for Environment, Food and Rural Affairs, 'Policy: Making the food and farming industry more competitive while protecting the environment', *Detail: genetic modification*, last updated 14 November 2014, accessed 26 January 2015.

82 Q4 [Dr Parr]; Q6

83 Q3 [Liz O'Neill]; Q26 [Liz O'Neill]

84 European Academies Science Advisory Council, *Planting the future: non-technical summary*, June 2013, p.3

85 Foresight, *The Future of Food and Farming: final report*, 2011, p.11

Box 3: Marker assisted selection

Plant breeding gradually improves the performance of crop plants through an iterative three stage process: i) genetically distinct parent plants are crossed on the basis of their individual characteristics; ii) the resulting progeny are screened for beneficial trait combinations, and iii) those offspring displaying desired traits are further bred from to eventually form new lines and varieties.[86]

The second stage of this process is often challenging because large numbers of plants may have to be grown for months or years before being screened, often for traits that are not easily identifiable (for example, disease resistance or drought tolerance). However, it is known that certain traits are strongly associated with specific genes or stretches of DNA and it is therefore sometimes possible to monitor the presence of this genetic material as a proxy for the trait itself. Once individuals possessing the desired trait have been identified through this molecular marker, they can be selected for further propagation, accelerating and improving the reliability of more conventional methods of selective breeding. This process is known as marker assisted selection (MAS), or marker assisted breeding.[87]

MAS has led to the development of several novel plant varieties, including salt-, acid- and drought-tolerant rice, disease resistant wheat and high yielding tomatoes.[88] However, it relies on the genetic variation already present in the crop population and is therefore more limited in its potential uses than some other advanced genetic approaches.[89]

28. Several witnesses emphasised the potential value of genetically advanced crops to the developing world and highlighted the global knock-on effects of European opposition to such technologies. Mark Lynas, a self-proclaimed former "anti-GM campaigner", stated that, in some regions of Africa, there was evidence of "increasing malnutrition resulting from the failure of staple crops like banana and cassava due to emerging new viral and bacterial diseases" and explained that "African scientists, as part of international public-sector collaborative efforts, have already developed GM cassava and banana which are resistant to both these diseases".[90] He argued that "the risk to food security in sub-Saharan African countries of not adopting GM technology is surely vastly greater than the risks of adopting it", but stated that "the prospect of any of these crops reaching farmers is slim due to the overpowering anti-GMO sentiment spread by many European-funded activist groups".[91] Mr Lynas highlighted the "chilling effect" that the EU regulatory regime (discussed in chapter 4) had exerted on the use of these technologies in the developing world, as "if a single grain" of genetically modified product were to be found in a shipment to Europe, "the entire trading system could be put at risk".[92] Dr Calestous Juma, Professor

86 The Royal Society, *Reaping the benefits*, October 2009, p.5

87 The Royal Society, *Reaping the benefits*, October 2009, p.5. See also Bertrand Collard and David J Mackill, "Marker-assisted selection: an approach for precision plant breeding in the twenty-first century", *Philosophical Transactions of the Royal Society B* vol 363 (2008), pp 557–572. Doi: 10.1098/rstb.2007.2170

88 Greenpeace, *Smart breeding: the next generation*, October 2014, annex

89 For further evidence on marker assisted selection see Q4 [Dr Parr]; Q110 [Mr Melchett, Professor Crute]; Q138 [Professor Crute] and Qq218-219 [Professor Stirling, Professor Tait]

90 GMC010 [Mark Lynas] paras 3-4

91 GMC010 [Mark Lynas] paras 4-5

92 GMC010 [Mark Lynas] para 6; para 9

of International Development at Harvard Kennedy School, agreed that diplomatic pressure from the EU had led to many African countries taking a "restrictive approach" to genetic modification, despite "evidence from several long-term studies" suggesting that such technologies were "successful at helping smallholder farmers increase their income through costs savings".[93] In its 1999 report, *Genetically modified crops: the ethical and social issues*, the Nuffield Council on Bioethics concluded that genetic modification did "not differ to such an extent from conventional breeding that it is itself morally objectionable" and stated that "the moral imperative for making GM crops readily and economically available to developing countries who want them" was "compelling".[94]

29. Ms O'Neill was particularly critical of what she called the "silver-bullet mentality that has been part of the promotion of GM" and the claim that "if we just fix this one particular trait, everything will be okay and we will have the crops we need".[95] However, we saw little evidence of this attitude amongst our witnesses. Professor Juma characterised "plant biotechnology" as "one important tool in addressing food insecurity", but neither he nor Mr Lynas suggested that it was a panacea.[96] The Agriculture and Horticulture Development Board stated that "all technologies" that could increase efficiency and provide potential economic, environmental or consumer benefits "should be fully appraised and evaluated" and Professor Baulcombe explicitly stated that "industrial agriculture by itself" was "not the answer" to today's agricultural challenges and needed to be considered alongside "traditional and organic" approaches.[97] He added that the idea that genetic modification could be a "silver bullet" was "completely dead now" and was therefore "not a valid objection to GM".[98] Industry representatives were particularly keen to dispel claims that they over-estimated the potential value of these techniques. Dr Julian Little, Chair of the Agricultural Biotechnology Council, stated that it was "very important that we put on record that we do not believe GM will be the silver bullet for all problems out there".[99] Dr Mike Bushell, Principal Scientific Adviser at Syngenta, went further, stating that he did not think that Syngenta had "ever said that GM is a silver bullet or a magic bullet of any sort; it is just a very important part of the farmer's toolkit".[100] The Minister agreed that it was "important" that "GM crops" were "not seen as a silver bullet and the solution to all of our agricultural problems", describing them as simply "one important technology among many whose potential we need to explore".[101]

30. **We received no evidence to suggest that genetic modification, or any other single technology, was widely viewed as a potential cure-all for global agricultural problems. It is clear that a diversity of approaches—technological, social, economic and political—will be required to meet the challenge of delivering sustainable and secure global food**

93 GMC023 [Dr Calestous Juma] paras 2 and 3.1

94 GMC035 [Nuffield Council]. See also Nuffield Council on Bioethics, *Genetically modified crops: the ethical and social issues*, May 1999, executive summary

95 Q51 [Liz O'Neill]

96 GMC023 [Dr Calestous Juma] para 3.1

97 GMC037 [Agriculture and Horticulture Development Board] para 2; Q3 [Professor Baulcombe]

98 Q3; Q51

99 Q185

100 Q185

101 Q445

production. However, advanced genetic approaches do have a role to play. We are convinced by the evidence provided to us that this suite of technologies is a potentially important tool, particularly in the developing world, which should not be rejected unless there is solid scientific evidence those technologies may cause harm.

Steering agricultural innovation

31. Given that multiple approaches are clearly needed in order to tackle global food insecurity, we were concerned by claims made by a small number of witnesses that, by pursuing advanced genetic techniques, society was effectively 'locking out' the alternatives. This argument was made most fully by Professor Andy Stirling, co-Director of the University of Sussex's Social, Technological and Environmental Pathways to Sustainability (STEPS) Centre. In a recent report commissioned by the Government Chief Scientific Adviser, Professor Stirling argued that "a diversity of well understood social, political and economic processes" had the effect of "steering" innovation pathways in particular directions, reinforcing those trajectories "favoured by the most powerful interests" at the expense of others that "may be more widely beneficial".[102] Professor Stirling told us that there was "quite a lot of prima facie evidence" that such processes had led to "a degree of lock-in with GM technology specifically, notwithstanding that there are alternatives showing great promise".[103] Professor Brian Wynne, University of Lancaster, agreed that there was a "big question" over whether advanced genetic approaches could "peacefully co-exist with all the other tools in the toolbox" or whether they would "swallow them up".[104] Peter Melchett, Soil Association, described genetic modification as a "one in, all in technology", adding:

> It is not one tool in the toolbox—it is a tool in the toolbox that, if you start to use it, destroys the other tools and becomes the only one you have available.[105]

32. Professor Stirling proposed a variety of mechanisms through which society could become 'locked in' to particular innovation trajectories; these included individual and institutional resistance to change, societal expectations about which technologies would be adopted in the future, exaggerated claims about a technology's potential value and about the certainty of the evidence underlying such claims.[106] The Nuffield Council on Bioethics, in its 2012 report on emerging biotechnologies,[107] explained the same phenomenon in slightly different terms:

> Central to the explanation of technological 'lock-in' is the idea that specific technological pathways, once embarked upon, become progressively difficult and costly to escape. In economic terms, this is generally attributed to the

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102 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.53

103 Q218

104 Q72

105 Q123

106 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.55

107 Professor Stirling was a member of the working group that produced this report.

> mutual adaptation of the technology itself and market conditions, learning effects and increasing returns to scale, etc. Technologies may also acquire 'momentum' from the feedback between technology and society through, for example, lifestyle adaptations to particular products.[108]

In light of the potentially serious consequences of such technological 'lock-in', we decided to explore these arguments further.

Resource allocation

33. When asked how the process of 'lock in' was operating in the case of genetic modification, Professor Stirling replied:

> There are many different mechanisms—it would take a long time to go through all of them—that are very well understood and explored, but one simple one is resources. Resources are limited: £1 million spent on that option is, by and large, £1 million not spent on another option within a particular sector.[109]

This chimed with an argument made by GM Freeze, that "conventional breeding programmes, conservation of agricultural biodiversity, work to rebuild degraded soils […] and other areas of agricultural development" were "under-resourced and unable to contribute their full potential to the UK economy" because of an excessive focus on genetic techniques.[110] Professor Paul Nightingale, University of Sussex, also stated that "GM research" was "strongly supported by the Government, industry and the Research Councils" and argued that "rejection of GM food by consumers should give pause to reconsider how much support it receives and whether limited resources could be more productively spent on technologies with greater potential for generating goods that consumers will pay for".[111]

34. We tested this argument with Dr Paul Burrows, Executive Director of Corporate Policy and Strategy at the Biotechnology and Biological Sciences Research Council (BBSRC), the largest public funder of UK plant science. The BBSRC's annual budget for 2013-14 was £484 million[112] and, according to Dr Burrows, it invests:

> in plant science—I am rounding the figures—around £70 million of public funding per year, and that primarily goes to universities and research institutes to do basic and strategic research, to understand the basic biology of plants, how they function, how they respond to stress and how they

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108 Nuffield Council on Bioethics, *Emerging technologies: technology, choice and the public good*, December 2012, para 1.24

109 Q229

110 GMC020 [GM Freeze] 4.2

111 GMC045 [Professor Nightingale] exec summary and para 31

112 Biotechnology and Biological Sciences Research Council, 'Spending overview', accessed 28 January 2015

> protect themselves against pests and diseases. It is a broad range of basic research which helps us understand plants much better.[113]

Of this £70 million, Dr Burrows estimated that around £4 million per year was spent on research exploring the potential for specific crops to be enhanced using advanced genetic techniques (the types of projects described in box 2).[114] An additional £10 million was spent on research which used genetic engineering as a "very helpful laboratory tool" (as detailed in box 1).[115] When asked whether the BBSRC had made any specific commitment to Government about future levels of funding for research into advanced genetic techniques, Dr Burrows replied in the negative and stated that the BBSRC would be "delighted to fund any of the range of technologies or approaches which will help us achieve productive yet more sustainable agriculture".[116] Professor Sir David Baulcombe, a BBSRC Council member, agreed that the BBSRC was open to "various approaches to developing science-based agriculture" and that the idea that there was "no appetite for funding alternative strategies for developing sustainable agriculture" was "just not true".[117]

35. In its 2009 report, *Reaping the benefits,* the Royal Society recommended that the UK Research Councils develop "a cross-council 'grand challenge' on global food crop security", which it stated would need to secure "at least £2 billion over 10 years to make a substantial difference".[118] In 2014, the UK Plant Sciences Federation made a similar call, stating that "Government and industry must work together to build capacity by doubling current funding across the spectrum of plant science".[119] According to this report, "more than 90% of UK plant scientists surveyed" also thought that "a better, more coherent strategy for UK research" was needed.[120] Both reports particularly highlighted the need for additional investment in what the Royal Society called "neglected" sciences, such as those related to crop management and agricultural practice,[121] which it considered "vital in meeting the challenge of food security".[122]

36. The Minister stated that the Government had done "a great deal" to specifically address the recommendations of the Royal Society's 2009 report and offered a number of examples, including the establishment of the 2013 *UK Strategy for Agricultural Technologies* (the 'agri-tech strategy'), a new strategic plan for global food security and a programme of research specifically focused on soil security.[123] George Freeman MP, Minister for Life Sciences, told us that the Government now spent approximately "£400 million a year" on agricultural research, although he acknowledged that, until recently, this investment had

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113 Q142

114 Q147

115 Q146. According to the Government. "over the three years to 2010/11, BBSRC spent £146m in total on crop research, of which £13m involved the use or production of GM crops for the purpose of enhancing agricultural traits". GMC051 [Gov] para 19

116 Q149

117 Q51

118 The Royal Society, *Reaping the benefits*, October 2009, p.x

119 UK Plant Science Federation, *UK Plant Science: current state and future challenges*, January 2014, p.3

120 UK Plant Science Federation, *UK Plant Science: current state and future challenges*, January 2014, p.16

121 For example, agronomy, soil science and agro-ecology.

122 GMC044 [Royal Society] para 4; The Royal Society, *Reaping the benefits*, October 2009, p.ix

123 Q459

been spread between "so many different pots that there was not really any strategic oversight of it".[124] He explained that the agri-tech strategy was intended to provide "a coherent strategy".[125] According to Mr Freeman, this document acknowledged that genetic approaches were "important", but recognised that "so are a range of other technologies that help us deliver more from less", and he told us that the strategy specifically highlighted areas such as "soil science and agronomy".[126] Dr Burrows told us that the UK Research Councils were also "investing more in that space" and that the BBSRC's latest strategic plan included a specific commitment to "do more on taking a systems approach to agriculture".[127] Mr Freeman argued that there was "a real commitment" from Government "to try and make sure that we are not just backing one deep technology", but a range of technologies "that will support more from less as farmers and growers find a use for them".[128] He stressed that the Agri-Tech Catalyst, a new centrally-funded research programme, was "technology blind".[129]

37. **We do not consider an annual Biotechnology and Biological Sciences Research Council investment of £4 million—from a total budget of nearly £500 million and a plant science budget of £70 million—to represent an excessive investment in advanced genetic approaches to crop improvement. We are also content that the Government's approach to agricultural research is balanced and does not focus excessively on genetic techniques. We therefore reject the claim that preferential investment in this field has prevented research from progressing in other areas of agricultural research.**

38. We found the funding breakdown provided by Dr Burrows very valuable; however, such data is not easily accessible.[130] Research Councils UK does not appear to publish aggregate information about how funding is allocated across different categories of research[131] and the annual Science, Engineering and Technology Statistics, published by the Department for Business, Innovation and Skills, do not drill down beyond broad "socio-economic objectives", such as energy, health and defence.[132] The need for more detailed funding data was raised in a recent Nuffield Council report on the culture of scientific research in the UK, which highlighted the need for funding bodies to "communicate clearly […] about funding strategies, policies and opportunities, and

124 Q456; Q462

125 Q456

126 Qq462-464

127 Q151

128 Q468

129 Q468

130 A similar breakdown was included in the BBSRC's 2008 position statement on "GM research in crops and other plants" but is not routinely available. For a copy of this statement, see: BBSRC, correspondence to Andrew Miller MP, April 2014.

131 In December 2013, Research Councils UK launched a 'Gateway to Research' portal which "affords a new opportunity to easily explore the entire breadth of research across all disciplines and industry sectors". This provides information on individual grants but does not appear to provide easy access to aggregate information and does not appear to categorise research into particular categories. See Research Councils UK, 'Gateway to Research', accessed January 28 2015

132 Department for Business, Innovation and Skills, 'Science, engineering and technology statistics 2013', 11 September 2013, Table 2.4

information about past funding decisions, particularly in areas where there are common misconceptions".[133]

39. **Claims of funding bias are difficult to refute on the basis of the information on government research spend that is currently published.** ***We recommend that the Government's annual Science, Engineering and Technology statistics be enhanced to provide greater aggregate detail on the areas of research in which public funds have been invested. We also recommend that each UK Research Council includes an aggregated breakdown—for example, at the level of each strategic 'theme'—in its annual report and provides additional information on past funding decisions in areas where there are common misconceptions, such as plant science.***

Intellectual property rights

40. Professor Stirling argued that technological 'lock in' could be "significantly further reinforced" by measures to "appropriate intellectual property".[134] In the case of agriculture, he claimed that "the most important factor typically differentiating GM technologies" from other innovations was their ability to enable "innovating firms to recoup investments by obtaining rents on intellectual property or global supply and value chains".[135] "For instance", he explained:

> transgenic crops are often deliberately engineered for tolerance to particular proprietary broad spectrum herbicides [for example, Monsanto's 'RoundUp' product], thus expanding their sales. Or the inclusion of particular transgenes can make the resulting organisms patentable, and thus more reliable sources of royalties. It is the resulting commercial forces and counterforces that help make the ensuing discussions so regrettably polarized.[136]

Liz O'Neill, GM Freeze, drew a similar distinction between genetically modified and traditionally bred crops, stating that the ability to patent genetically modified crops made a "big difference to the way that the crops and seeds are controlled".[137] She added that "the one absolute position" held by GM Freeze was that "genetic resources are a public good and should not be owned by anybody".[138] Greenpeace publicly takes a similar position, opposing "all patents on plants, animals and humans, as well as patents on their genes" and claiming that "the real reason" for the commercial development of genetically modified crops "has not been to end world hunger but to increase the stranglehold multinational biotech companies already have on food production".[139] The STEPS Centre, of which

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133 Nuffield Council on Bioethics, *The culture of scientific research in the UK*, December 2014, p.35

134 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.55.

135 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.56.

136 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.56.

137 Q7

138 Q4

139 Greenpeace, 'Genetic engineering: what's wrong with genetic engineering', accessed 16 January 2015; Greenpeace, 'Global campaigns: Promoting sustainable agriculture', accessed 28 January 2015.

Professor Stirling is co-director, agreed that intellectual property rights had allowed multinationals to exercise "corporate control" and had helped to steer innovation in the direction of "intensive, monopolistic GM seed-chemical combinations" rather than technologies that "arguably promise wider and more sustainable benefits and lower uncertainties, such as marker assisted selection, open source and participatory breeding".[140]

41. Other witnesses highlighted the benefits of intellectual property rights and argued that their use was not limited to those hoping to make a profit. Dr Mike Bushell, Syngenta, stated that intellectual property was "something [that] society gives people because there is a benefit to society for doing it that way" and the Science Council agreed that "robust intellectual property rights" were "important components of a strong innovation system".[141] According to Dr Bushell, this is particularly true "where you have a very long regulatory time frame and large costs are involved", as is currently the case in the EU GMO regulation, as "if there was no competition-free period to exploit the inventions, nobody would make the investments".[142] Dr Julian Little, Chair of the Agricultural Biotechnology Council, stated that patents were "endemic" within the agricultural sector, but pointed out that they worked "not just for multinationals, but for all sorts of different people", including publicly funded researchers.[143]

42. GM Freeze claimed that, as well as concentrating control of the global seed market, the use of patents and "other forms of control over genetic resources" had "block[ed] independent research" into the potential effects of these technologies.[144] Ms O'Neill stated that "one simply cannot do independent research on GM" because, for example, "Monsanto licensing agreements specifically preclude research on their seed".[145] Professor Michael Bevan, a programme leader at the John Innes Centre, disagreed, telling us that while he had never done any research on Monsanto seeds, he had "certainly worked on seeds and genetic material provided by other companies".[146] He stated that he did not see any inconsistency "in the goals of maximising the impact from research, making data freely available to other researchers and protecting any important and potentially commercialisable discoveries", adding that the patents on most first generation products had "now expired anyway".[147] The Royal Society concluded in its 2009 *Reaping the benefits* report that intellectual property law could "enable, encourage or constrain" agriculture and that the use of patents, in particular, could have "mixed consequences".[148] It recommended that the Government "review relevant intellectual property systems to ensure that patenting or varietal protection of new seed varieties does not work against poverty alleviation, farmer-led innovation or publicly funded research efforts".[149]

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140 GMC004 [STEPS]

141 Q193 [Dr Bushell]; GMC047 [Science Council] para 4.4

142 Q193

143 Q194

144 GMC020 [GM Freeze] para 5.1

145 Q41. Monsanto was offered the opportunity to respond to this statement but did not do so.

146 Q164

147 Q158

148 GMC044 [Royal Society] para 4; The Royal Society, *Reaping the benefits*, October 2009, p.5; p.45

149 GMC044 [Royal Society] para 4; The Royal Society, *Reaping the benefits*, October 2009, p.x

43. **We have not been convinced by the argument that the application of intellectual property rights to genetically advanced crops has hindered other innovation trajectories and we have seen little evidence to support claims that patents pose a significant barrier to independent research. However, it is clear that this subject raises strong emotions and we agree with the Royal Society that this is a complex matter that warrants further consideration.** ***We recommend that the Government conduct a review of the intellectual property landscape, specifically in relation to agricultural technologies, and its potential impact on the commercialisation of both conventionally bred and genetically improved crops. We would expect this to be delivered to our successor Committee by the end of 2015.***

Framing

44. Professor Stirling, commenting on behalf of the STEPS Centre, initially criticised our inquiry for having been framed as though agricultural innovation was "about GM or nothing", arguing this this "compounds the side-lining of innovations that arguably promise wider and more sustainable benefits and lower uncertainties, such as marker assisted selection, open source and participatory breeding".[150] Professor Brian Wynne, University of Lancaster, agreed that framing was often "a big problem" when discussing this subject and was "nearly always narrowed down" in the way described by Professor Stirling.[151] The implications of emerging biotechnologies being framed in this way were considered in a 2012 report by the Nuffield Council on Bioethics, which stated that framing was "indispensable to understanding the social meaning of biotechnologies" and stressed "the importance of considering alternative frames in the governance of emerging biotechnology" in order to counteract the "many social processes" operating to "'close down' the plurality of frames that may be applied".[152] In the specific case of genetic modification, however, it is not clear whether the way in which this technology has been framed has primarily shut out alternative options, or whether the polarisation of the debate that it has led to has in fact acted as a barrier to the acceptance of genetic modification itself. According to Dr Jack Stilgoe, University College London, "presupposing any particular solution" to food security issues, "whether or not it is GM", "immediately forces people into a yes or no polarised discussion" and Professor Helen Sang, Society of Biology, stated that this polarisation made it "challenging" for the "pro-GM and the anti-GM" factions to engage in constructive discussion and debate.[153] Síle Lane, Sense about Science, added that describing GM "in isolation, not putting it in the context in which it has been used" had "not been helpful to public understanding of GM" and was part of the reason why "why we are here now having these discussions years and years" after GM products were first developed.[154]

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150 GMC004 [STEPS]. We stated our reasons for doing so in paragraph 7. Professor Stirling later acknowledged that he had seen the inquiry "move beyond that framing" in ways that he "certainly would welcome". Q262 [Professor Stirling]

151 Q61

152 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and the public good*, December 2012, paras 3.29-3.31

153 Q74 [Dr Stilgoe]; Q157 [Professor Sang]

154 Q60

45. **We recognise that the debate about innovation in agriculture is often too narrowly framed around the single subject of 'GM' and we agree that this has likely led to an unnecessary polarisation of views. However, we see no compelling evidence that this has 'locked out' alternative innovation options: if anything, it may have had the effect of prejudicing the public against advanced genetic approaches.** We discuss the subject of framing further in chapter 6.

Conclusions: Keeping our options open

46. In its 2012 report on emerging biotechnologies, the Nuffield Council made the point that "the technological solutions to human problems that are chosen are not the only ones possible, and may, indeed, not always be the 'best' ones".[155] In order to reduce the risk of sub-optimal choices being made, the Council argued strongly that UK innovation policy needed to "foster diversity of technological research", in part by widening the evaluative frame beyond "the single dimension of economic growth" towards a more inclusive notion of social value.[156] To achieve this, it saw a need for the Government to adopt a "more circumspect approach" to technology policy, in which "commitments to particular technological pathways should be evaluated not only in terms of their expected future impacts but also by comparison to possible alternative pathways", with greater recourse to public engagement and deliberation.[157] In order to facilitate cross-departmental thinking and "avoid focusing on economic growth as the central theme of research policy", the Nuffield Council's report specifically recommended that consideration be given to:

> bringing Government research policy and funding bodies under a senior minister (i.e. of Cabinet rank) free from departmental responsibilities to ensure that research properly reflects all the objectives of Government, rather than those of a particular department.[158]

This recommendation bears resemblance to our own repeated call for the Government Office for Science (GO-Science) to be moved from its current location in the Department of Business, Innovation and Skills to the Cabinet Office—the 'heart' of government and the primary seat of cross-departmental decision-making. As we have previously made clear, it is our view that GO-Science would be able to "more easily fulfil its remit of ensuring that the best scientific evidence is utilised across government" from this central location.[159] According to the Nuffield Council's argument, such a move would also have the benefit of widening the frame within which research policy is set beyond "business" and economics, towards "other, important values".[160] Evidence of the dominance of this economic frame was recently provided by the Government's new science and innovation strategy, which

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155 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and public good*, December 2012, para 10.5

156 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and public good*, December 2012, p.xxiii, chapter 7 overview, para 43.

157 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and public good*, December 2012, para 10.5

158 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and public good*, December 2012, 7.56

159 Science and Technology Committee, Ninth Report of Session 2013-14, *Government horizon scanning*, HC 703, para 39

160 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and public good*, December 2012, 10.17

was described as a plan for making the UK "the best place in the world for science *and business*" (emphasis added) and was titled: "Our Plan for Growth".[161]

47. **It is clear from the evidence we have received that fears that the pursuit of advanced genetic approaches to crop improvement inevitably 'locks out' alternative technologies and solutions are ill-founded. Nevertheless, we recognise the need for society to remain open to a variety of innovation trajectories and for policy-makers to look beyond the single dimension of economic growth when considering the potential costs and benefits of any emerging technology.**

48. **In this respect, we endorse many of the recommendations of the Nuffield Council's recent report on this subject and reiterate our previous conclusion that the Government Office for Science is not best located in the Department for Business, Innovation and Skills, where its frame of evaluation risks being invariably dominated by economic considerations. *In its response to this report, the Government should set out how the Nuffield Council's work on emerging biotechnologies has informed its research policy. We are particularly interested in how it has responded, or intends to respond, to the Council's call for structural reorganisation.***

Much of this chapter has focused on the extent to which the pursuit of advanced genetic solutions has inhibited the progress of other agricultural innovations. The next chapter focuses on the ways in which genetic approaches themselves have been impacted by the current EU regulatory environment.

[161] Department for Business, Innovation and Skills, 'Policy paper: Our plan for growth: science and innovation', 17 December 2014, accessed 28 January 2015

4 The EU regulatory environment for genetically modified organisms

EU GMO regulation

49. The import, processing and cultivation of genetically modified organisms (GMOs) in European Union (EU) Member states is closely regulated. This is achieved through four main pieces of EU legislation:

- the Contained Use Directive (2009/41/EC),[162] which lays down measures for the contained use of genetically modified micro-organisms, for example, in research;
- the Deliberate Release Directive (2001/18/EC),[163] which outlines the risk assessment required before any release of GMOs to the environment; and
- two GM food and feed regulations which set out the traceability and labelling (EC 1830/2003)[164] and assessment and authorisation (EC 1829/2003)[165] requirements for marketing of food or feed containing or derived from GMOs.[166]

Under this legislation, all GMOs must undergo risk assessment by the European Food Safety Authority (EFSA) before they can be imported or grown in the EU. Once EFSA has delivered its scientific opinion—typically stating whether or not the assessed GMO is as safe as its conventionally-bred counterpart—the European Commission formulates a draft decision on how to manage any potential risks highlighted by EFSA and whether or not to grant EU-wide permission to import or cultivate that GMO. This draft authorisation decision is voted on by a Standing Committee consisting of Member state representatives. In the event that the required qualified majority[167] is not achieved, the decision on whether or not to accept the Commission's proposal is referred to an Appeal Committee, where a second vote is taken. If the Appeal Committee vote is also indecisive, the Commission is empowered to make a final authorisation decision.

50. To date, the EU has granted approval for the import of over 40 genetically modified (GM) food and feed varieties, including cotton, maize, oilseed rape, sugar beet, yeast and soybean, which is widely used across Europe as poultry feed.[168] However, according to the Government, "since 1998 every attempt to reach an EU decision on [cultivation of] a GM crop has resulted in an inconclusive vote, with no qualified majority for or against the

162 Council Directive 2009/41/EC

163 Council Directive 2001/18/EC

164 Council Regulation 1830/2003

165 Council Regulation 1829/2003

166 Parliamentary Office of Science and Technology, *GM crops and regulation*, POSTnote 482, October 2014. Note, the Contained Use Directive (90/219/EEC) referred to in this document was repealed and replaced by Directive 2009/41/EC as of 6 May 2009

167 Under a qualified majority, any decision must be voted for by Member states representing at least 72% of the population of the European Union (232 votes from a possible 321). The UK has been allocated approximately 9% of these votes (29 in total). See Europa, *The Council of the European Union*, accessed 16 December 2014.

168 See the EU register of authorised GMOs, accessed 26 January 2015.

proposed authorisation".[169] As a result, several applications for GMO cultivation have become 'stuck' in the regulatory system for many years while others have been withdrawn. Only one GM crop is currently authorised for cultivation in the EU: a variety of insect-resistant Bt maize (see paragraph 11) approved in 1998. This accounts for approximately 30% of Spain's total maize production (more than 100,000 hectares) and is also grown in Portugal, the Czech Republic, Romania and Slovakia.[170] However, this product counters a pest not problematic in the UK and is therefore not currently grown in this country.[171]

The precautionary principle

51. The current EU regulatory framework is generally considered to have been heavily informed by the precautionary principle. There is no single agreed definition of the precautionary principle and "considerable debate" as to what it means and how it can be implemented.[172] However, a useful definition was offered in 2005 by the UN's World Commission on the Ethics of Scientific Knowledge and Technology, which described it as follows:

> When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm.[173]

The precautionary principle has its roots in environmental law. It was first formally adopted in the German Clean Air Act of 1974 and its application was later extended through the 1992 Rio Declaration on Environment and Development.[174] Having informed EU environmental policy for several years, in 2000 the principle was the subject of a European Commission 'Communication', which outlined the Commission's "approach to using the precautionary principle" and established "guidelines for applying it", in an attempt to "avoid unwarranted recourse to the precautionary principle, as a disguised form of protectionism".[175] Its role in EU environmental policy was later enshrined in the 2007 Lisbon Treaty.[176]

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169 GMC051 [Gov] para 8

170 David Baulcombe, Jim Dunwell, Jonathan Jones, John Pickett and Pere Puigdomenech, *GM science update: a report to the Council for Science and Technology*, March 2014, p.9. See also GMC029 [SCIMAC] para 34

171 GMC029 [SCIMAC] para 34; GMC051 [Gov] para 12

172 European Environment Agency, *Late lessons from early warnings: the precautionary principle 1896-2000*, 2001, p.12.

173 United Nations Educational, Scientific and Cultural Organization, World Commission on the Ethics of Scientific Knowledge and Technology, *The Precautionary Principle*, March 2005, p.14

174 Principle 15 of the Rio Declaration states: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". United Nations Environment Programme, *Rio Declaration on Environment and Development*, June 1992. See also European Environment Agency, *Late lessons from early warnings: the precautionary principle 1896-2000*, 2001, p.13.

175 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, para 2

176 Article 191 (2) of Lisbon Treaty states: "Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay".

52. The influence of the precautionary principle on the EU's regulatory approach to GMOs is reflected in the language of the current legislation. The Deliberate Release Directive, 2001/18/EC, states that the precautionary principle was "taken into account" in its drafting and that it must also "be taken into account" in its implementation, in relation to both risk assessment and risk management.[177] The final version of the recent amendment to this Directive—discussed later in this chapter—similarly includes a clause requiring that the precautionary principle "always be taken into account in the framework" of this Directive "and its subsequent implementation".[178] EC 1830/2003, on traceability and labelling, also stipulates that legislation should "facilitate the implementation of risk management measures in accordance with the precautionary principle" and an online summary of legislation, published by the EU's publications office, explicitly acknowledged that this legislation was adopted "in accordance with the precautionary principle".[179] Nevertheless, when questioned on the subject of the principle, Eric Poudelet, Director of Safety of the Food Chain at the European Commission, told us repeatedly that the Commission had "never implemented the precautionary principle for the authorisation of GMOs".[180]

53. **It is clear to us that an interpretation of the precautionary principle has significantly influenced the EU's approach to GMO regulation and we consider the claim, made by a representative of the European Commission, that the principle has never been implemented for GMO authorisation to be, at best, disingenuous. If the precautionary principle is to avoid being used as a political tool, greater clarity is needed regarding when, and how, it has been used. *In order to avoid future ambiguity, we recommend that the Commission clearly and publicly state when it has drawn on the precautionary principle in the policy formation process.***

The precautionary principle is discussed further in chapter 5.

Is the current regulatory system fit for purpose?

54. According to the Government, the current EU legislative framework for the cultivation of GMOs, "as written", could provide for "a pragmatic assessment and authorisation process".[181] However:

> In practice, the operation of the regime is very dysfunctional because Member states do not share a common outlook on this issue. The agreed regime should mean that GM crops are cleared for planting if they pass the required safety assessment. In practice, even if a crop has received a favourable EFSA [European Food Safety Authority] assessment, a significant

177 Council Directive 2001/18/EC. Note, this Directive also stipulates (in article 4 and annex II) that both risk management and environmental risk assessment of GMOs should be carried out "in accordance with the precautionary principle". See article 4 and annex II.

178 Amendment to Council Directive 2001/18/EC, 'Position of the European Parliament adopted at second reading on 13 January 2015', P8_TC2-COD(2010)0208

179 Council Regulation 1830/2003; EUR-Lex, 'Deliberate release of genetically modified organisms (GMOs)', Summary of EU legislation, accessed 26 January 2015.

180 Q367; Q381

181 GMC051 [Gov] para 8

> number of Member states still object to proposed EU approvals due to their political views on GM.[182]

This broadly reflects a widely held view. The National Farmers' Union, for example, similarly described the current regulatory process as "dysfunctional", claiming that it was "strongly driven by politics and emotion rather than sound science", in contradiction of "the EU's stated policy goals of competitiveness, productivity and delivering a knowledge-based bioeconomy".[183] The James Hutton Institute agreed that "political rather than safety issues" were to the fore in the EU regulatory process, and that this was "inhibiting adoption of GM technology" in Europe.[184] This point was made particularly strongly by industry. Syngenta stated that the current system's attempt "to integrate science and politics" created the "ideal opportunity to create delays", for example through politically-based "claims of 'scientific uncertainty' which lead to further requests for data resulting in further delays in approval".[185] BASF agreed that the EU regulatory system was "frustratingly slow" and "dysfunctional" and added that it was "unduly influenced by political lobbyists without a scientific evidence-based approach".[186]

55. Some of these issues were acknowledged by those involved in the process itself. Professor Joe Perry, Chair of EFSA's GMO panel, recognised that Member states tended to vote "on political grounds, in many cases ignoring the […] scientific evidence" provided by EFSA, despite this being against World Trade Organisation rules.[187] He added that aspects of the system had been "abused by Member states for political reasons that have nothing to do with science".[188] Professor Perry also acknowledged the existence of long procedural delays, although he attributed these to "political inertia once the EFSA opinion has been received" by the European Commission, rather than to flaws in the risk assessment process itself.[189] Mr Poudelet also appeared to recognise the system's weaknesses; however, like the Government, he saw "no problem in the legislative framework" and stated that "the problems" with the system came through "the process of adoption, where member states have to vote with the qualified majority system".[190] Mr Poudelet admitted that the Commission was "guilty" of failing to meet its statutory duty to adopt a draft decision within three months of receiving EFSA's opinion, but stated that this was a deliberate move to give it time to "find a solution that commands the widest possible support from member states" before forcing a vote.[191]

56. Although there was widespread agreement about the inefficiency of the current regulatory system, not everyone agreed that the politicisation of the decision-making

182 GMC051 [Gov] para 8

183 GMC022 [NFU] para 3.4; 4.1

184 GMC009 [James Hutton Institute] exec summary

185 GMC036 [Syngenta] para 3

186 GMC019 [BASF]para 4; GMC052 [Innogen] para 5

187 GMC016 [Professor Perry]. See also GMC029 [SCIMAC] para 29 (iv)

188 GMC016 [Professor Perry]

189 GMC016 [Professor Perry] para 9

190 Q352

191 Q362

process facilitated by the European Commission made it dysfunctional. The Advisory Committee on Releases to the Environment (ACRE) drew a distinction between risk assessment, as performed by EFSA, which "should be based on objective scientific principals", and subsequent decision-making about risk management, which might be rightly "expected" to be "influenced by non-scientific and often political considerations".[192] This distinction was also highlighted by Mr Poudelet, who stated that, as risk manager, the European Commission had to "take into account other legitimate [non-scientific] factors, which EFSA does not" —"you call that politics".[193] He continued:

> For me, politics are not negative; they are the way politicians—you are politicians—drive the rules and lives of our citizens. We do not see politics as a negative input. We see politics as a way that the regulation of particular innovative products like GMOs could be accepted by our citizens.[194]

Mr Poudelet stated that "today, in most member states—maybe not the UK—GMOs are not really accepted for food".[195] He therefore saw the EU's failure to authorise GMOs for cultivation as a legitimate reflection of this position. In contrast, the Government characterised the EU regime as "dysfunctional" and argued that it imposed a "significant opportunity cost" on the UK: a country in which "most people […] are open-minded or don't feel strongly about GM crops".[196] Only eight cultivation applications now remain in the EU regulatory system while, in contrast, nearly 100 genetically modified crops have been approved for use in the US.[197] According to Professor Rosemary Hails, Chair of the Advisory Committee on Releases to the Environment, one of these applications has "been there since 1996, I think", and "12 applications have been withdrawn" because "those who submitted them have now given up".[198] Professor Sir David Baulcombe, University of Cambridge, stated that, under the current system, "the opportunity for any individual member state to take advantage of GM is being blocked by the political agenda of other member states" and added that "the decisions by Monsanto and BASF to reduce crop biotechnology investment in Europe were a direct consequence" of the regulatory regime.[199] BASF confirmed that its decision to "halt development of GM crops for the European market was to a large extent the result of the slow and unpredictable nature of a European regulatory system" and Syngenta stated that, because of the current "political impasse", it considered "the possibility to translate agricultural GM research into commercial products in the EU" to be "essentially zero".[200] A further "perverse political outcome" of the current system, according to Professor Joyce Tait, Innogen Institute, was that "the more onerous you make the regulatory system, the more difficult it is for small

192 GMC030 [ACRE] para 11

193 Q354

194 Q360

195 Q360

196 GMC051 [Gov] paras 13, 16 & 20

197 See the EU register of authorised GMOs, accessed 26 January 2015; Parliamentary Office of Science and Technology, *GM crops and regulation*, POSTnote 482, October 2014

198 Q430

199 GMC027 [Professor Baulcombe] paras 23 & 13

200 GMC019 [BASF] para 7; GMC036 [Syngenta] para 10

companies to get through that to the market", reinforcing the oligopolistic tendency that underlies some people's concerns about the genetic modification.[201]

57. Several witnesses stated that the EU regime had also damaged the UK research environment. The Government indicated that "employment in the UK crop biotechnology industry sector fell significantly" between 1996 and 2006 and highlighted that, between 2005 and 2009, there were over 4000 trials of genetically modified crops in the US, compared with just three in the UK.[202] It estimated that if UK crop biotechnology research had progressed in the way that is had done in the US, "there could have been nearly 900 additional science jobs created, with an estimated annual additional income (salaries) generated of £57 to £77 million".[203] Professor Guy Poppy, Chief Scientific Adviser to the Food Standards Agency, told us that regulatory issues were "having consequences in terms of the willingness of industry and, to some extent, the scientists in universities and research institutes to pursue work in this area".[204] The Agricultural Biotechnology Council agreed that current regulations had "resulted in companies and scientists naturally focusing investments and time in areas of the world with more predictable and workable approval systems".[205] It continued:

> A recent Phillips McDougall report suggests that 30 years ago, nearly one third of the $6.5 billion that the major agrochemical and seed companies invested in R&D was focussed on products for the European market. Today, that figure is less than 8%, with EU agriculture only benefiting from products that are also relevant to other markets, a testament to the collapse in confidence in the European regulatory system for pesticides, seeds and traits.[206]

58. During the drafting of this report, the EU amended the regulations with regard to GM crops. In essence, the changes recognise the delays inherent in the system and there is now provision for countries that do not wish for GM crops to be grown in their countries to ban the growth of any crops approved on an EU wide basis.

59. **A regulatory system under which it takes many years—sometimes decades—to reach a decision cannot possibly be considered fit for purpose. Evidence clearly shows that the current EU regulatory regime for GMOs is not working, and has not worked for some time. We await signs of whether the recent changes will significantly change the outcome for companies seeking approval to grow GM crops in Europe.**

Issues of regulatory design

60. The operational problems underlying the current stalemate in the EU stem from three fundamental issues of regulatory design.

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201 Q239 [Professor Tait]

202 GMC051 [Gov] para 13

203 GMC051 [Gov] para 13

204 Q430 [Professor Hails]

205 GMC031 [ABC] para 12

206 GMC031 [ABC] para 12

1. Regulatory trigger

61. The current EU regulatory system for novel crop plants is technology-specific; genetically modified crops are regulated because of the method by which they were created rather than because of the traits that they display. Several influential UK and European bodies—including the European Academies Science Advisory Council (EASAC),[207] the Prime Minister's Council for Science and Technology,[208] the Biotechnology and Biological Sciences Research Council (BBSRC)[209] and the Advisory Committee on Releases to the Environment (ACRE)[210]—have advocated a move to a trait-based regulatory system, as is currently operated in Canada (see box 4). They have made this recommendation on the basis of two professed flaws of the current process-based system:

i) lack of evidence to support the underlying premise that genetically modified crops present higher risk than their conventionally bred counterparts; and

ii) the failure of process-based regulation to cope with advances in technology.

Box 4: The Canadian regulatory system for plants with novel traits

In Canada, genetically modified and conventionally bred plants are all regulated under the same 'trait-based' system. Under this system, crops are subject to full risk assessment and regulation only if they are defined as being a 'plant with a novel trait' (a 'PNT'). In order to be classified as a PNT, a plant must display a characteristic not seen in any previously approved product. However, the system does not distinguish between technologies: a PNT may be produced by conventional breeding, mutagenesis, genetic modification or any other technique, and not all genetically modified plants will necessarily be defined as PNTs.[211]

According to the European Academies Science Advisory Council, "this approach acknowledges the fact that it is the product, and not the process, that warrants regulation because it is the presence of novel traits in a plant that potentially pose an environmental or health risk, and not how the traits were specifically introduced".[212] It added that "a key strength of the Canadian regulatory system is that while the techniques used by plant breeders continue to evolve, the regulatory trigger for PNTs will remain current and consistent".[213]

Canada is the fourth-largest global producer of genetically modified crops and has so far approved over 120 GM crop/trait combinations through this system.[214]

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207 European Academies Science Advisory Council, *Planting the future: final report*, June 2013, p.37

208 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015.

209 Biotechnology and Biological Sciences Research Council, New techniques for genetic crop improvement: position statement, September 2014, accessed 26 January 2015.

210 Advisory Committee on Releases to the Environment, *Report 2: Why a modern understanding of genomes demonstrates the need for a new regulatory system for GMOs*, August 2013, p.1

211 European Academies Science Advisory Council, *Planting the future: final report*, June 2013, p.17

212 European Academies Science Advisory Council, *Planting the future: final report*, June 2013, p.17

213 European Academies Science Advisory Council, *Planting the future: final report*, June 2013, p.17

214 European Academies Science Advisory Council, *Planting the future: final report*, June 2013, p.50

The relative safety of genetically modified and conventionally bred crops

62. Professor Sir David Baulcombe, University of Cambridge, explained that the EU regulatory system was initially based on process rather than trait in order to accommodate particular "concerns about hazards associated with GM" which arose when the regulation was first developed in 1990.[215] According to Professor Baulcombe, at this time "little was known about plant genomes and the mechanisms of GM" and "there were features of the GM plants that were either surprising or difficult to monitor".[216] However, he argued, "in 2014, the situation has changed" and we can now "be confident" that "the risk associated with GM crops is negligible".[217] The Society of Biology agreed and pointed out that:

> Worldwide, over 175 million hectares are dedicated to GM crop cultivation, accounting for 12 percent of arable land, and no inherent risks have so far been identified to human or animal health from this consumption or to the environment from their cultivation.[218]

63. The conclusion that genetically modified crops pose no greater risk than their conventionally bred counterparts is supported by what the Science Council referred to as an "increasingly strong international body of scientific research which says that GM crops are safe for human and animal consumption".[219] A 2010 European Commission report, looking back on 130 EU-funded research projects, concluded that GMOs were not inherently any more risky than conventionally bred crops and EASAC, "the collective voice of European science", stated in 2013 that "the scientific literature shows no compelling evidence" linking genetically modified crops "with risks to the environment or with safety hazards for food and animal feed greater than might be expected from conventionally bred varieties of the same crop".[220] According to the Royal Society, "no evidence exists that GM methods, as defined in current legislation, are intrinsically more dangerous than other less regulated approaches".[221] This conclusion has been strongly echoed by voices operating within the EU establishment. Professor Anne Glover, former Chief Scientific Adviser to the President of the European Commission, has stated publicly her confidence "in saying that there is no more risk in eating GMO food than eating conventionally farmed food".[222] Professor Joe Perry, European Food Safety Authority (EFSA), also stressed his confidence in saying that those GMOs that had received a positive opinion from EFSA were "as safe as their conventional counterparts".[223] In light of such statements, Dr Paul Burrows, BBSRC, judged that "the scientific consensus" on this matter appeared "quite sound".[224] Nevertheless, Dr Doug Parr, Greenpeace UK, stated that there was "plenty of scientific opinion out there that takes a different view", citing a recent statement issued by the

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215 GMC027 [Professor Baulcombe] para 7

216 GMC027 [Professor Baulcombe] para 7

217 GMC027 [Professor Baulcombe] para 8

218 GMC046 [Society of Biology] para 4

219 GMC046 [Society of Biology] para 4; GMC047 [Science Council] para 5,2

220 European Academies Science Advisory Council, 'What is EASAC', accessed 26 January 2015. European Academies Science Advisory Council, *Planting the future: non-technical summary*, June 2013, p.5

221 GMC044 [Royal Society] para 10

222 "No risk with GMO food, says EU chief scientific advisor", Euractiv, 24 July 2012, accessed 26 January 2015.

223 Q327

224 Q165

European Network of Scientists for Social and Environmental Responsibility, signed by 297 scientists, which contends that there is "no scientific consensus on GMO safety".[225] Peter Melchett, Soil Association, acknowledged that "the majority of scientists think it [GM] is safe" but highlighted "a relatively small amount of peer-reviewed, published science on long-term health effects of GM food" which he suggested offered "grounds for concern".[226]

64. In setting out their inherent concerns about the safety of genetic modification, several witnesses portrayed gene insertion as a random process with potentially unexpected effects. Mr Melchett, for example, characterised genetic engineering as "disruption of the genome, with unknown consequences" and made a link between this and the "inherent uncertainty" of the technology.[227] Dr Parr similarly portrayed the insertion process as a source of inherent risk and stated that this produced "unpredictable outcomes" that could "potentially lead to unpredictable effects when released into the environment".[228] GM Freeze agreed that gene insertion could produce "potentially dangerous effects".[229]

65. However, these arguments were rejected by other expert witnesses. Professor Baulcombe explained that "gene silencing", one of the "unpredictable outcomes" suggested by Dr Parr, was "now well understood as an avoidable complication" of first generation transgenic techniques.[230] "Additionally", he explained, "with advances in DNA sequencing technology, the second level of uncertainty is eliminated because it is now relatively easy to characterize the complete genome sequence and the transgene insertion sites in the recipient genome".[231] Professor Ottoline Leyser, Royal Society, stated that gene insertion happened regularly in nature and highlighted that not all genetic crop improvement techniques involved introducing genes from outside the normal gene pool.[232] According to Professor Leyser:

> The idea that [genetic modification] is inherently more risky compared with what we now know about all the conventional approaches that we use is not tenable based on the current science. I am not saying that it is risk free, but nor is conventional breeding.[233]

66. Aside from the "inherent" risk posed by the process of genetic modification, Liz O'Neill, GM Freeze, highlighted her organisation's concern about a number of specific consequences.[234] She stated, for example, that "in north and south America, where a large amount of GM is grown, we have seen a huge growth in pesticide-resistant weeds, a massive decline in the monarch butterfly, and a large number of serious contamination incidents".[235] In response to Ms O'Neill, Professor Leyser stated that "all the things that you

225 Q9 [Dr Parr]

226 Q123

227 Q123

228 Q20

229 GMC020 [GM Freeze] para 6.3

230 GMC027 [Professor Baulcombe] para 8

231 GMC027 [Professor Baulcombe] para 8

232 Q9

233 Q9

234 Q14

235 Q21

mentioned, absolutely all of them" were not to do with the technology itself, but "the trait that has been introduced".[236] She explained:

> If one takes herbicide tolerance, for example, and all the issues about weed resistance and so on and so forth, there are non-GM, single gene, herbicide-tolerant crops out there. […] They have exactly the same, or possibly slightly worse, issues associated with them. This is exactly the point. If one is concerned about particular environmental issues, such as the spread of herbicide tolerance, campaigning against GM is the wrong way to go, because it is not caused by GM. It is caused by herbicide resistance. If your concerns are those environmental issues, you should be campaigning against herbicide resistance, however it is introduced.[237]

The Royal Society explained that process-based regulation inevitably resulted in these types of "inconsistencies", because the same phenotypic trait, for example herbicide resistance, "may fall in or out of the scope of the regulations […] simply because of the way it was introduced".[238] As a consequence, according to Professor Leyser, conventionally-bred herbicide-tolerant crops undergo "no scrutiny whatsoever before they are put in the field", despite them producing the same type of potentially harmful effects as those listed by Ms O'Neill.[239]

67. Given the balance of evidence, the Science Council stated that the Government needed "to display confidence in the scientific consensus around the safety of GM foods".[240] We saw limited evidence of this happening. In its evidence to us, the Government made clear its support for genetic crop improvement but stopped short of explicitly acknowledging that crops produced via these technologies posed no greater risk than conventionally bred crops. There is no statement to this end on the relevant policy pages on GOV.UK and it has not been a feature of recent speeches on the topic, such as that made by the Secretary of State in January 2015.[241] The Minister did acknowledge to us that the EU risk assessment process was "more than robust enough to ensure that authorised GM products will be as safe as their non-GM counterparts", but made no more generalised comment about the scientific consensus that genetically modified crops pose no inherent risk.[242]

68. **The current EU legislative framework for novel plants is founded on the premise that genetically modified plants pose inherently greater risk than their conventional counterparts. The weight of peer-reviewed scientific evidence, collected over many years, has shown this to be unjustified. Where genetically modified crops have been shown to pose a risk, this has invariably been a result of the trait displayed—for example, herbicide tolerance—rather than the technology itself. We are disappointed that the Government has not more publicly argued this fact. *We recommend that the***

236 Q22

237 Q22

238 GMC044 [Royal Society] para 11

239 Q22

240 GMC047 [Science Council] para 5.3

241 Department for Environment, Food and Rural Affairs, *Environment Secretary speech at the Oxford farming conference*, published 7 January 2015, accessed 26 January 2015

242 Q475

Government publicly acknowledge that genetically modified crops pose no greater inherent risk than their conventional counterparts. A statement recognising this fact should be included in the Government's response to this report and relevant areas of GOV.UK should be updated to reflect this.

New techniques for genetic crop improvement

69. Current EU legislation defines a GMO as "an organism, with the exception of human beings,[243] in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination".[244] As a result of its focus on process rather than trait, a list of particular techniques considered to meet this definition are specifically included in the legislation (for example, the typical first generation process of transgenic insertion) while others are expressly excluded (for example, in vitro fertilisation and the induction of polyploidy,[245] a technique commonly used in plant breeding). In a 2013 report on new plant breeding techniques, the Advisory Committee on Releases to the Environment (ACRE) stated that it had been experiencing an increased number of enquiries "as to whether organisms produced by certain techniques are captured by the EU's GMO legislation".[246] Professor Rosemary Hails, Chair of ACRE, stated that this was leading to "a necessary but nonsensical debate" about whether particular new methods should be considered 'GM'.[247] In recognition of this issue, the Biotechnology and Biological Sciences Research Council (BBSRC) recently issued a position statement on new techniques for genetic crop improvement. This stated that "novel genetic techniques" were "advancing rapidly" and that "the boundaries between established GM and non-GM techniques" would, in the future, "become increasingly blurred", placing "even more emphasis on the advantages of a trait-based [regulatory] system".[248] It concluded that "a regulatory system based on the characteristics of a novel crop, by whatever method it has been produced, would provide more effective and robust regulation than current EU processes".[249] Professor Joe Perry, European Food Safety Authority (EFSA), stated that current EU legislation was "less and less apt" to deal with emerging genetic crop modification techniques and that the Commission was aware of this problem.[250] The Commission also acknowledged this, but was not able to tell us how it intended to resolve this issue or when a solution was likely to be found.[251]

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243 If humans were not excluded from this definition, the Deliberate Release Directive would effectively ban the 'release' of individuals who had undergone gene therapy.

244 Directive 2001/18/EC of the European Parliament and of the Council, Definitions (2), 12 March 2011.

245 A polyploid plant is one that contains more than two sets of chromosomes. Polyploid plants are "often larger and more vigorous" than diploid plants and artificially induced polyploidy is therefore a relatively common breeding technique. Noel Kingsbury, *Hybrid: The history and science of plant breeding*, (Chicago, 2009) p.258; p.422.

246 Advisory Committee on Releases to the Environment, *ACRE advice: new techniques used in plant breeding*, August 2013, p.1.

247 Q423

248 Biotechnology and Biological Sciences Research Council, New techniques for genetic crop improvement: position statement, September 2014, accessed 26 January 2015.

249 Biotechnology and Biological Sciences Research Council, New techniques for genetic crop improvement: position statement, September 2014, accessed 26 January 2015.

250 GMC016 [Professor Perry]; Q333

251 Q399

70. **The EU's process-based regulatory system for novel crops is increasingly proving itself to be incapable of dealing with advances in technology. This raises the prospect that potentially important agricultural innovations will be hindered, or even halted, by inappropriate regulation, while potentially harmful crops may escape appropriate control if they are produced using techniques not captured by GMO regulations.**

71. **We consider the current process-based EU legislative framework for GMOs to be fundamentally flawed and unfit for purpose.**

Government policy on process- versus trait-based regulation

72. George Freeman MP, Minister for Life Sciences, expressed concern at what appeared to be "a dangerous trend towards regulating by process rather than product" and stated that his "strong preference" was "that we regulate by product".[252] However, Lord de Mauley stated that if a move was to be made towards trait-based novel crop regulation, there was "a very real possibility of ending up with the unsatisfactory GM regime simply being applied more generally to any novel crop".[253] He stated that the Government therefore needed to "tread very carefully with this idea" and explained that its "immediate focus" was "on trying to improve the existing GM regime".[254] Professor Guy Poppy, Chief Scientific Adviser to the Food Standards Agency, also pointed out that while trait-based regulation might represent an improvement to the current framework, "if the member states, through block vote, decide to vote against" genetically modified products for political reasons, "you will end up in exactly the same situation".[255]

73. **We acknowledge that there is a need to "tread carefully" with regard to trait-based regulation and recognise that a change in UK policy on this issue is unlikely to pay immediate dividends. However, we consider it likely that a move to trait-based regulation at EU-level will eventually be forced by technological progress and suggest that the Government would be wise to prepare for such a change.** ***We recommend that the Government formally adopt a move to trait-based novel plant regulation as a long-term policy goal and begin to develop its preferred framework for such a system so that this can inform EU discussions. The Government should provide our successor committee with an update on this work by the end of 2015.***

74. ***In the meantime, we urge the European Commission to take a pragmatic and evidence-based approach to its development of policy regarding emerging techniques for genetic crop improvement. We remind it that such techniques are likely to be vital to ensuring future global food security and that inappropriate regulation may have significant negative consequences for both the UK and the EU as a whole.***

252 Q453

253 Q453

254 Q453

255 Q424

2. Consideration of risks and potential benefits

75. We have seen strong evidence that the use of first generation genetically modified crops can deliver significant benefits, both to farmers and to the environment (see paragraph 13).[256] However, as many witnesses pointed out, while risks are comprehensively assessed under the EU regulatory system, potential benefits are not currently accounted for, leading to what the John Innes Centre called "a very one-sided decision making process".[257] The Advisory Committee on Releases to the Environment (ACRE) described this as a "fundamental problem with the current regulatory framework" and several witnesses agreed that "a more explicit risk/ benefit analysis, taking compensatory measures into account, would allow decision-makers to take more informed decisions".[258]

76. Professor Joe Perry, European Food Safety Authority (EFSA), confirmed that, at present, EFSA could not, "according to the legislation covering regulation of GMOs […] consider benefits, only adverse effects".[259] Consideration of both the benefits of action, and the risks of inaction, is a widely accepted principle of good risk management[260] and Professor Perry explained that "the risk managers", the European Commission and the member states, were "meant to do a detailed analysis of benefit".[261] However, he continued, whether due to "lack of resources or expertise", "quite clearly this is not being done".[262] As a consequence, he said, "potential benefits such as the possible reduction in carbon emissions associated with reduced tillage in herbicide-tolerant systems, are not formally assessed at any point in the regulatory system".[263] Eric Poudelet, European Commission, agreed that it was the Commission's role, as risk manager, to introduce "other legitimate factors" for consideration following scientific risk assessment, and stated that the Commission had "established an organisation" with this in mind.[264] He described this as:

> a bureau of cost benefit where 18 member states have been asked to deliver expertise. They will issue a report, probably next year, about the cost of cultivation in particular, and whether the cultivation of GM in Europe brings some benefit for the farmer, the environment and citizens.[265]

The body to which Mr Poudelet refers is the European GMO Socio-Economics Bureau (ESEB), a technical working group of the European Commission's Joint Research Centre. ESEB's objective is to:

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256 Wilhelm Klümper and Matin Qaim, "A Meta-Analysis of the Impacts of Genetically Modified Crops", *PLOSOne*, November 3 2014. DOI: 10.1371/journal.pone.0111629.

257 GMC012 [John Innes Centre] para 10

258 GMC030 [ACRE] para 8; exec summary

259 GMC016 [Professor Perry] section 5

260 See, for example, European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000

261 Q325

262 Q325

263 GMC016 [Professor Perry] section 5

264 Q377

265 Q377

> define methodological tools to investigate the crop/trait or product-specific ex-ante and ex-post socio-economic implications, on users and non-users of GMOs, of the cultivation and processing of GMOs along the seed-to-shelves chain in Europe.[266]

ESEB is currently only considering one product—genetically modified insect-resistant ('Bt') maize—and it is not clear whether or not it will include within its scope the potential environmental benefits offered by GMOs. A "final reference document" on Bt maize is due for publication in December 2015.[267]

77. **Good risk management requires the potential benefits of an action to be thoroughly considered alongside the risks. It also requires a consideration of the risk of failing to act. Current GMO legislation fails to adequately recognise this point and the European Commission, as risk manager, has proved itself incapable of taking (or unwilling to take) these factors into account on a discretionary basis. This has led to a one-sided decision-making process and has sent a misleading message to the public about the potential value of these products, to the economy, society and the environment. *We urge the Commission to give greater recognition to the full array of potential social, economic and environmental benefits offered by GMOs and the potential consequences of failing to adopt these products during EU risk assessment and risk management processes.***

3. National versus collective decision-making

78. European GMO regulation is currently prescribed through a series of EU Directives (see paragraph 47). The Science Council noted that while such instruments could be effective in harmonising response across member states, they "do little to recognise individual member states' scientific and political cultures, and public attitudes to the adoption and application of new science and technologies".[268] Evidence suggests that these attitudes vary widely across the EU, particularly in relation to agricultural biotechnology. A 2010 Eurobarometer survey found that, in general, Europeans did "not see benefits" of genetically modified foods and were "not in favour" of their development.[269] However, it noted that EU citizens were "divided in their optimism about biotechnology and genetic engineering" and that UK citizens were markedly more enthusiastic about the field than those from other member states.[270] According to the Government, "the available evidence suggests that most people in the UK are open-minded or don't feel strongly about GM crops".[271] Sense about Science highlighted the British public's greater appreciation of "public sector research" and the potential "non-commercial benefits" offered by GMOs compared to that of other member states, and stated that while discussion about genetic crop improvement in the UK was "now relatively balanced and evidence-related", this discussion had "not progressed in the same way […] at European level".[272] Professor Brian

266 Joint Research Centre/European GMO Socio-Economics Bureau, *Terms of reference*, no date provided.

267 Joint Research Centre/ European GMO Socio-Economics Bureau, no date provided.

268 GMC047 [Science Council] para 3.2

269 European Commission, *Eurobarometer: biotechnology*, Special Eurobarometer 341, Wave 73.1, October 2010, p.7.

270 European Commission, *Eurobarometer: biotechnology*, Special Eurobarometer 341, Wave 73.1, October 2010, p.7.

271 GMC051 [Gov] para 20

272 GMC015 [Sense about Science]

Wynne, University of Lancaster, downplayed these differences, stating that his own research had indicated a high degree of convergence in public attitudes across the UK, Spain, Italy, Germany and France with regard to "the factors lying behind opinions and attitudes".[273] However, he acknowledged that this was not necessarily reflected in the widely differing positions of these countries' respective governments.[274]

79. Several witnesses pointed out that these differences of political opinion had led to issues in the operation of the centralised regulatory process, both at the risk assessment and risk management stages. The European Food Safety Authority (EFSA), the organisation responsible for GMO risk assessment, is "an independent European agency" intended to operate "separately from the European Commission, European Parliament and EU Member states".[275] However, some witnesses considered its work in this area to have become increasingly influenced by EU politics. The Agricultural Biotechnology Council stated that there were "increasing concerns over a proliferation of new regulatory requirements which are a political response to anti-GM campaigns without any scientific basis addressing legitimate safety concerns".[276] It cited the example of compulsory 90-day rodent feeding studies, which were recently made a mandatory requirement through Regulation 503/2013.[277] Professor Perry, EFSA, agreed that these studies were made compulsory "for political reasons", despite his panel's "repeated advice" that there was "no good scientific reason to do so".[278] According to Food Standards Agency, "the Regulation was not supported by the UK and a number of other Member states who saw it as an unjustified increase in animal testing, contrary to agreed policies on reducing animal experimentation".[279] However, "the majority of Member states voted in favour of the Regulation and it subsequently came into effect in June 2013".[280]

80. Several witnesses argued that exaggerated claims of 'scientific uncertainty' had also been used as a political tool, both during risk assessment and risk management. Professor Perry stated that "those with an agenda against GMOs" frequently attempted to "overemphasise uncertainty for their own ends", particularly through the misuse of safeguard clauses, which he stated were often used as "a purely political ploy, containing no scientific content of any merit".[281] Syngenta agreed that "political opposition to GM products" had given rise to unjustified "claims of 'scientific uncertainty'" and offered several examples in which this tactic had been effective in delaying or preventing authorisation (see, for example, box 5).[282] Professor Joyce Tait, Innogen Institute, indicated that this was to be expected, as it was "part of the political process" for those who opposed a technology on ideological grounds to "seek to maximise the level of uncertainty in order to

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273 Qq62-63. See also Claire Marris, Brian Wynne, Peter Simmons and Sue Weldon, *Public Perceptions of Agricultural Biotechnologies in Europe: Final Report of the PABE research project*, December 2001.

274 Qq63-64

275 European Food Safety Authority, 'Who are we', accessed 26 January 2015.

276 GMC031 [ABC] para 5

277 GMC031 [ABC] para 5; para 29. See also GMC016 [Perry]; GMC015 [Sense about Science] para 1.4

278 GMC016 [Perry]

279 GMC048 [FSA]

280 GMC048 [FSA]

281 GMC016 [Professor Perry]

282 GMC036 [Syngenta] para 3; paras 13-15

make a political case".[283] She contrasted this with the scientific process, which "seeks to minimise the uncertainty by doing more experiments", and argued that these two processes should therefore, as far as possible, be kept separate.[284]

Box 5: Maize 1507

Maize 1507 is a herbicide- and insect-resistant crop developed by DuPont-Pioneer. It was first submitted to the European Food Safety Authority (EFSA) for risk assessment in 2000 and, following "substantial delay" due to a change in GMO legislation and requests for additional data, received its first positive safety opinion from EFSA in early 2005.[285]

In response to concerns raised during a technical meeting between the European Commission, member states, EFSA and DuPont-Pioneer, in July 2006 the Commission asked EFSA to deliver a further scientific opinion. Over the following years, maize 1507 was assessed and re-assessed multiple times, eventually receiving a total of seven positive EFSA opinions.[286] The European Commission is legally obliged to prepare a draft authorisation opinion within three months of receiving an opinion from EFSA; however, it continually failed to do so and, as a result, in 2010 DuPont-Pioneer launched a legal action against the Commission. This was successful and in a September 2013 ruling, the European Court of Justice found that the Commission had "failed to fulfil its obligations" under the relevant legislation "by failing to submit to the Council" a draft authorisation decision on maize 1507.[287]

In November 2013, thirteen years after the product first entered the regulatory process, the European Commission passed a draft opinion on maize 1507. This recommended that the product be authorised for cultivation. However, in February 2014 the European Parliament approved a Resolution calling on the Council of the European Union to "reject the Commission proposal" on the basis that "the long-term effects of GMO cultivation and the effects on non-target organisms have, thus far, not been adequately taken into account in the risk assessment framework".[288] It further called on the Commission "not to propose to authorise any new GMO variety and not to renew old ones until the risk assessment methods have been significantly improved".[289] A final authorisation decision on maize 1507 remains outstanding.

81. While Professor Tait saw a need to maintain a distinction between the scientific and political aspects of risk governance, she, and several other witnesses, acknowledged that

283 Q258

284 Q258

285 GMC031 [ABC] para 2

286 GMC031 [ABC] para 2

287 InfoCuria, 'Judgement of the General Court (Seventh Chamber), 26 September 2013', Case-law of the Court of Justice, Case T-164/10

288 European Parliament, 'Resolution of 16 January 2014 on the proposal for a Council decision concerning the placing on the market for cultivation, in accordance with Directive 2001/18/EC of the European Parliament and of the Council, of a maize product genetically modified for resistance to certain lepidopteran pests', B7-0007/2014

289 European Parliament, 'Resolution of 16 January 2014 on the proposal for a Council decision concerning the placing on the market for cultivation, in accordance with Directive 2001/18/EC of the European Parliament and of the Council, of a maize product genetically modified for resistance to certain lepidopteran pests', B7-0007/2014

both processes relied on subjective, value-based judgements as well as objective evidence.[290] According to Professor Andy Stirling, University of Sussex, "in order to interpret a risk assessment", for example, "even if we assume it is complete, you still have to know what level of safety you are going to require. That is a value judgment".[291] The notion of 'harm' is also a value-based concept central to the process of scientific risk assessment. The Advisory Committee on Releases to the Environment (ACRE) highlighted that environmental harm was not defined in current GMO legislation and argued that this had led to risk assessments becoming generalised "data gathering exercises" rather than focused tests of plausible risk hypotheses.[292] Professor C J Pollock, ex-Chair of ACRE, argued that, in the absence of any "formal definition of harm", "impact" was increasingly being used as a substitute—"not a sensible way to proceed", in his view, as "all agricultural systems impact on the receiving environment".[293] Professor Perry, EFSA, disputed this claim, stating that change was "not equivalent to harm" and was not treated as such by EFSA.[294] However, he acknowledged that it was often difficult to establish what level of change was likely to lead to biologically relevant effects and suggested that deciding where this line should be drawn was "probably the responsibility of the risk manager" rather than the risk assessor.[295]

82. Value-based considerations are also key to risk management. Professor Paul Nightingale, University of Sussex, explained that while scientific experiments such as those considered during risk assessment could "provide convincing evidence that something causes harm", they could never "fully establish [that] something is safe", so "what counts as safe is the result of a negotiated and often contested process".[296] Professor Nightingale argued that "uncertainty about safety" provided "a legal route to address non-health concerns" which were "difficult to articulate" elsewhere in the regulatory process and therefore saw the "high regulatory standards" that GMOs were required to meet as "a reflection of the operation of democracy, not a failing of science".[297] However, Professor Sir Mark Walport, the Government Chief Scientific Adviser, stated that there was a need for society to "be a bit more honest about when we are talking about science and when we are talking about values".[298] He continued:

> The broader European point is that, inevitably, values about individual innovations vary between nation states. The question is: should the values of one group of countries trump the values of another? That brings us to the principle of subsidiarity on GM, which I hope we are moving to, where GM foods can be regulated at European level but individual countries can choose to opt out of growing them.[299]

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290 Q258 [Professor Tait]

291 Q257

292 GMC044 [ACRE] para 20

293 GMC013 [Professor Pollock] para 7

294 Q316

295 Q316

296 GMC045 [Professor Nightingale] para 5

297 GMC045 [Professor Nightingale] para 5

298 Q294

299 Q294

The Minister stated that the Government "strongly support[ed]" decisions about whether or not to cultivate EU-approved GM crops being taken "at member state level".[300]

83. The principle of subsidiarity is defined in Article 5 of the Lisbon Treaty. This states that:

> Under the principle of subsidiarity, in areas which do not fall within its exclusive competence, the Union shall act only if and insofar as the objectives of the proposed action cannot be sufficiently achieved by the Member States, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level.[301]

According to a lay summary published by the EU, the principle of subsidiarity "ensures that decisions are taken as closely as possible to the citizen and that constant checks are made to verify that action at Union level is justified in light of the possibilities available at national, regional or local level".[302] It requires that "the Union does not take action […] unless it is more effective than action taken at national, regional or local level".[303]

84. **Science and politics each have a role to play in both risk assessment and risk management. However, while risk management is rightly a politically-led process, risk assessment must be led by science if it is to effectively contribute to evidence-based policy-making. This distinction has not been sufficiently observed in the EU's regulation of GMOs.**

85. **In attempting to centralise decision-making about risk management, the current EU regulatory system limits the ability of member states to take local political factors into account. The result is undue politicisation of the risk assessment process. Those opposed to genetic modification seek to exaggerate scientific uncertainty in order to block or delay authorisation. This, in turn, leads to stalemate at the voting stage, where strongly conflicting political positions inevitably prevent agreement from being reached. To resolve this, decision-making about risk management, including the decision whether or not to cultivate an authorised GMO, must be repatriated to member states. *We consider the current EU regime to be at variance with the principle of subsidiarity. We remind the Council, the Commission and the Parliament of their responsibility to observe this principle.***

Recent developments

86. In October 2014, Vytenis Andriukaitis, the new Commissioner to the European Commission's Directorate General for Health and Consumers ('DG Sanco'), stated that he would "review the legislation applicable to the authorisation of genetically modified

300 Q451

301 Lisbon Treaty, Article 5 (3)

302 Europa, 'Summaries of legislation: glossary: subsidiarity', accessed 28 January 2015

303 Europa, 'Summaries of legislation: glossary: subsidiarity', accessed 28 January 2015

organisms" within "the first six months" of his tenure.[304] This followed an earlier pledge by the new President of the European Commission, Jean-Claude Juncker, to "make sure that the procedural rules governing the various authorisations for GMOs are reviewed".[305] In apparent reference to a February 2014 request by the European Parliament for the Commission "not to propose to authorise any new GMO variety and not to renew old ones until the risk assessment methods have been significantly improved",[306] he continued:

> I would not want the Commission to be able to take a decision [on GMO authorisation] when a majority of Member states has not encouraged it to do so.[307]

Eric Poudelet, Director, Safety of the Food Chain at DG Sanco, confirmed to us that Mr Juncker intended to "review the [GMO] decision-making process, to avoid taking decisions that are against a clear majority of member states" and that the Commission would prepare a proposal to this end by April 2015.[308]

87. In addition to these planned changes to the decision-making process, an amendment to the Deliberate Release Directive, passed by the European Parliament in January 2015, is due to come into effect this spring.[309] As initially drafted by the Commission in 2010, this proposal acknowledged that GMO cultivation was "an issue with a strong local/regional dimension" and granted member states greater power to make decisions at a national level.[310] However, some of these powers were rescinded in later drafts and while the final version allows member states to prohibit cultivation of authorised GMOs on non-scientific grounds, it provides no assurance that authorisation will be granted to those crops that have received a positive safety opinion.[311] In the words of the Minister: "There is discretion to member states to stop the process. There is not the discretion to individual member states to proceed".[312]

88. Eric Poudelet, European Commission, acknowledged that the final text of this amendment "substantially modifies the proposal we made in 2011", but appeared to remain optimistic about its potential impact.[313] He explained that because those Member states opposed to GMO cultivation would now have confidence that they could prohibit

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304 European Parliament, 'Answers to the European Parliament questionnaire to the Commissioner-Designate, Vytenis Andriukaitis', 2014, p.4

305 Jean-Claude Juncker, *A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change*, opening statement in the European Parliament plenary session, 15 July 2014, p.15.

306 European Parliament, 'Resolution of 16 January 2014 on the proposal for a Council decision concerning the placing on the market for cultivation, in accordance with Directive 2001/18/EC of the European Parliament and of the Council, of a maize product genetically modified for resistance to certain lepidopteran pests', B7-0007/2014

307 Jean-Claude Juncker, *A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change*, opening statement in the European Parliament plenary session, 15 July 2014, p.15.

308 Q386

309 Amendment to Council Directive 2001/18/EC, 'Position of the European Parliament adopted at second reading on 13 January 2015', P8_TC2-COD(2010)0208

310 European Commission, 'Regulation amending Directive 2001/18/EC', 13 July 2010, 2010/0208 (COD)

311 Amendment to Council Directive 2001/18/EC, 'Position of the European Parliament adopted at second reading on 13 January 2015', P8_TC2-COD(2010)0208

312 Q477

313 Q393

cultivation in their own territories, "we expect that they will not abstain or that they will give a favourable vote when we present the [authorisation] decision to be voted on".[314] Others, however, were less confident. Dr Julian Little, Agricultural Biotechnology Council, stated that he "really doubt[ed]" that this legislation would "allow UK farmers to access GM" and expressed concern that:

> this is going to be more a licence to ban than a licence to operate. Our concern is that it will give cover for countries that want to ban the use of these products, but very little for countries that want to move forward.[315]

Dr Mike Bushell, Principal Scientific Adviser at Syngenta, praised the Government's "leadership" in supporting this amendment but stated that there was "uncertainty" about its "ability to unblock the regulatory process".[316] He added that the change "rather risks damaging the principles of a single market and bringing in all sorts of intra-common market trade issues".[317]

89. The Government initially described the amendment to us as a "breakthrough" which could "unblock the EU system" by allowing "more national self-determination".[318] However, the Minister later stated that he was "disappointed" with the eventual outcome of negotiations and was concerned that it would "stifle our ability to benefit from GM technology".[319] He explained:

> It will mean that decisions on whether or not to cultivate EU-approved GM crops can now be taken at member state level. That is something we strongly support, and so it should undo the logjam in EU approvals and allow applications to be authorised quicker than hitherto. Our concern is that we still need GM crops to be authorised at EU level before they can be grown here, and because the proposal will allow other member states to implement GM bans not based on scientific evidence it may deter companies from making applications for EU approval.[320]

The Minister acknowledged that the final position was "not what the UK would ideally have liked" but stated that the Government must move on and "consider what we do now".[321] He stated that there were "several strands" to this, including continuing to "engage strongly with the three pillars of the EU institution", "pressing for the outstanding applications for EU approval to be authorised as soon as possible" and speaking to the agricultural biotechnology industry "to gauge its view on the prospects for GM developments in the UK and EU" in light of the amendment.[322]

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314 Q394

315 Q191

316 Q191

317 Q191

318 GMC051 [Gov] para 18; para 10

319 Qq447-8

320 Q451

321 Q446

322 Q446; Q451

90. **The hard won amendment to the Deliberate Release Directive is intended to ease problems with the operation of the regulatory system by ceding more power to Member states. However, it does nothing to resolve underlying weaknesses in the regulations or to prevent those hostile to GMOs from voting against authorisation in order to maintain the current EU-wide 'ban' on GMO cultivation. It may also do little to attract the agricultural biotechnology industry back to Europe. We commend those Governments that have provided leadership in attempting to secure more fundamental legislative change but share their view that the agreed amendment is far from satisfactory.**

91. **In our view, decisions about access to and use of safe products should be made by national governments on behalf of the populations that elected them, not by the EU. The most significant flaw in the current EU regulatory system for GMOs is its continued failure to enable Member states to make such decisions without prejudice.** ***We remind those in the EU who are opposed to GMO cultivation that the purpose of shared regulation should be to ensure mutual protection from unsafe products, not to unjustifiably restrict the choices available to other elected governments and the citizens whom they represent. We encourage all member states to vote in favour of authorising those products that have been deemed safe by the European Food Safety Authority so that national governments can make their own decisions about how best to act in their electorate's interests.***

92. ***We also encourage the new President of the European Commission, Mr Jean-Claude Juncker, and the new Health and Consumers Commissioner, Mr Vytenis Andriukaitis, to bear this point in mind in their planned review of the procedural rules governing GMO authorisation.***

Conclusion: the need for regulatory reform

93. This chapter has explored several significant flaws in the design and operation of the current EU regulatory process for genetically modified organisms (GMOs). These have long been recognised by the Government and it has made laudable efforts to try and resolve them, primarily by "trying to improve the current system" through small, incremental changes.[323] The Government was receptive to more wholescale changes, such as those recently supported by the Council for Science and Technology, but told us that it considered it "unlikely that in the foreseeable future EU agreement could be secured to implement such a fundamental departure from the existing GM control regime". It maintained that its "immediate focus" was on "trying to improve the existing GM regime".[324] Other witnesses challenged this approach. The Advisory Committee on Releases to the Environment acknowledged that short term solutions based on the current system may be attractive, but stated that they would "perpetuate an approach that is not consistent with the scientific evidence and that will continue to cause problems in the future".[325] The Council for Science and Technology similarly stated that the EU regulatory

323 GMC051 [Gov] para 7

324 GMC051 [Gov] para 7; Q453 [Lord de Mauley]

325 Advisory Committee on Releases to the Environment, *Report 2: Why a modern understanding of genomes demonstrates the need for a new regulatory system for GMOs*, August 2013, p.9

process needed to be "rebalanced to reflect the evidence" and stressed that "we need the right regulatory framework that will encourage continued research into solutions to current and future problems facing UK agriculture".[326] In its recent report on food security, the Environment, Food and Rural Affairs Committee stated that "the Government must continue to work within the EU to argue for a system which is more flexible for those member states that wish to take advantage of GM technology, while still ensuring that all EU consumers are protected, in the same way it does with non-GM technologies".[327] It added: "Progress towards this objective must be research and science-led".[328]

94. **We understand the challenge of securing major legislative change in the EU—particularly in relation to this subject—and therefore the Government's inclination towards delivering small improvements to the current regime rather than attempting a more significant overhaul. However, fundamental flaws in the design of this legislative framework have created a regulatory process that is not fit for purpose, has driven research activity out of the EU and which is putting the UK's agricultural future at risk. Substantial regulatory reform is no longer merely an option, it is a necessity. *We recommend that the Government publicly state its long-term commitment to major reform of the EU legislative framework for genetically modified organisms and other novel crops.***

95. This Committee scrutinises the actions of the UK Government and the UK Government is therefore the target of most of our recommendations. However, much of the power to bring about the changes that we, and many others, advise, lies in the hands of the European Commission and its leadership. ***We urge the European Commission to consider the conclusions and recommendations set out in this report and provide our successor committee with a formal response, by the end of 2015, to those issues for which it has responsibility.***

326 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015

327 Environment, Food and Rural Affairs Committee, Second Report of Session 2013-14, *Food Security*, HC243, 1 July 2014, para 132

328 Environment, Food and Rural Affairs Committee, Second Report of Session 2013-14, *Food Security*, HC243, 1 July 2014, para 132

5 Precaution, risk and uncertainty

96. In attempting to better understand the reasons for the current EU regulatory situation with regard to genetically modified organisms (GMOs), we paid particular attention to the way in which the precautionary principle had been interpreted and applied. Speaking in general terms, the Government Chief Scientific Adviser, Professor Sir Mark Walport, told us that he was "afraid" that:

> the precautionary principle has been used as a method of putting a red stop light in front of innovation rather than recognising that innovation is something where you need to consider both the benefits and risks. Sometimes there may be an amber light and it may be necessary to collect more evidence; on other occasions it may be that the balance of not doing something is worse than doing something.[329]

In this chapter, we explore the extent to which Sir Mark's characterisation of the precautionary principle as a potential barrier to innovation is justified and consider how the balance between precaution and innovation might be better managed.

EU GMO regulation: a misuse of the precautionary principle?

97. As was previously described (see paragraphs 49-51), the precautionary principle is generally considered to have played a significant role in informing the current EU regulatory framework for genetically modified organisms. This framework was initially developed in the 1990s, at a time when, according to the Royal Society, there was "an absence of evidence of whether GMOs posed different or greater risks to human health and/or the environment than organisms developed using existing methods".[330] However, it stated that "our understanding of genomes and experience of using GM crops has expanded considerably" since then and added that, "where risks have been identified", they have been shown to "relate to the trait that has been introduced rather than the method by which it was introduced".[331] It added:

> the consensus of scientific bodies is that the scientific evidence no longer justifies the precaution of controlling organisms *specifically* because they were generated using recombinant DNA technology.[332]

Professor Joyce Tait, Innogen Institute, agreed that while precaution may have been justified "when we were first considering how to regulate GM crops", when "we did not have very much information about their risks and benefits", it would now "be very reasonable to relax the precautionary principle and make the regulatory system adaptive in the context of the new knowledge we now have about GM crop development".[333] GM

329 Q288

330 GMC044 [Royal Society] para 20

331 GMC044 [Royal Society] para 21

332 GMC044 [Royal Society] para 21

333 Q220 [Professor Tait]

Freeze, however argued that the EU's precautionary approach to GMO regulation remained "entirely appropriate because a number of negative effects have been identified", including "the documented environmental impact of planting Roundup Ready crops, and other effects for which it is not currently possible to evaluate either the likelihood or impact to an acceptable level of certainty".[334] Professor Paul Nightingale, University of Sussex, agreed that the principle was "being properly applied" in the case of GMOs because "the conditions for its application are met": that is, scientific uncertainty and the potential for serious and irreversible harm.[335]

98. In attempting to unpick these arguments and establish whether or not continued recourse to the precautionary principle is appropriate for all products generated via genetic modification, we drew on the European Commission's own 2000 Communication on the topic, which aims to establish guidelines for the principle's application. This document stresses that "the implementation of an approach based on the precautionary principle should start with a scientific evaluation" and that recourse to the principle "presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified".[336] It stipulates that "the precautionary principle can under no circumstances be used to justify the adoption of arbitrary decisions" and that subsequent risk management measures "may not be of an arbitrary nature".[337] The European Commission does not precisely define the precautionary principle in this document; however, it stipulates its relevance to:

> those specific circumstances where scientific evidence is **insufficient**, **inconclusive** or **uncertain** and there are indications through preliminary **objective scientific evaluation** that there are **reasonable grounds for concern** that the **potentially dangerous effects** on the environment, human, animal or plant health may be inconsistent with the **chosen level of protection**.[338] [Emphasis added.]

99. The evidence that we have detailed elsewhere in this report enables us to demonstrate that not one of these requirements continues to be universally met for crops produced via genetic modification. Taking these in turn:

- As we have previously concluded, the weight of scientific evidence collected over many years demonstrates that the premise that genetically modified crops pose greater risk than their conventional counterparts is unjustified (see paragraph 61-62). We are satisfied that the scientific evidence relating to the use of genetically modified crops is neither **insufficient**, **inconclusive** nor **uncertain**.

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334 GMC020 para [GM Freeze] 1.5

335 GMC045 [Professor Nightingale] para 33

336 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, p.4

337 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, p.13

338 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, p.10

- We have also concluded that any risk that genetically modified crops have been shown to pose derives from the trait displayed rather than any inherent risk posed by the technology itself (see also paragraph 63-64). In other words, **objective scientific evaluation** has provided no indication that there are **reasonable grounds for concern** that these products might lead to **potentially dangerous effects** on the environment, human, animal or plant health.

- Society has indicated, through its use of other technologies posing comparable risk, (for example, non-GM herbicide tolerant crops), that it considers the level of risk posed by genetically modified organisms to be acceptable (see paragraph 63). That is, the risk posed is not inconsistent with society's **chosen level of protection**

According to Dr Mike Bushell, Syngenta, "what we are seeing in many cases is not the application of the precautionary principle as defined in the Commission's own documents, but actually a smokescreen of uncertainty being put around technology to stop it happening for politically motivated reasons".[339]

100. **We agree with the European Commission that a precautionary approach is appropriate in circumstances where scientific evidence is insufficient, inconclusive or uncertain and when there is reason to believe that potentially dangerous effects on the environment, human, animal or plant health might result if precaution is not exercised. However, it is clear from the evidence that we have received that these conditions are not met simply because a crop has been produced via genetic modification. Continued recourse to the precautionary principle in relation to all genetically modified crops is therefore no longer appropriate. Indeed, it has acted as a barrier to progress in this field.**

101. The European Commission's Communication on the precautionary principle states that "reliance on the precautionary principle" is "no excuse for derogating from the general principles of risk management".[340] It lists these as:

- **Proportionality**, which requires that "measures based on the precautionary principle must not be disproportionate to the desired level of protection and must not aim at zero risk";

- **Non-discrimination**, which requires that "comparable situations should not be treated differently and that different situations should not be treated in the same way, unless there are objective grounds for doing so";

- **Consistency**, according to which "measures should be consistent with the measures already adopted in similar circumstances or using similar approaches"'

- **Examination of scientific developments**, followed by re-examination and modification of precautionary measures as appropriate; and

339 Q187 [Dr Bushell]

340 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, p.18

- **Examination of the benefits and costs of action or lack of action**, from both economic and wider societal perspectives.[341]

Our work during this inquiry strongly suggests that these requirements are not being met in the case of GMO regulation. We have already referred to the strong scientific consensus regarding the comparative safety of existing GMO products relative to their conventional counterparts. In light of this, several witnesses considered the current regulatory regime to be both "disproportionate" and inflexible to scientific developments.[342] Witnesses also pointed out the rigorous risk assessment required for GMOs compared with other plant technologies (for example, non-GM herbicide-tolerant crops)[343] and the stringent risk management measures applied to these products compared with other comparable products (for example, pesticides).[344] This suggests a breach of the principles of both non-discrimination and consistency. The failure of the current regulatory system to take into consideration the benefits of action or costs of inaction was also frequently highlighted (see paragraph 72-74).

102. **There are vast discrepancies between the European Commission's stated approach to applying the precautionary principle and its adoption in practice. Uncertainty about how the principle is being used at EU level is not helped by the lack of a consistent definition.** ***We recommend that the European Commission consult with stakeholders in order to update its 2000 'Communication' on the precautionary principle. The updated document should include a clear definition of the principle and should stipulate the necessary conditions for it to be used as a basis for EU policy. In future, when the European Commission draws upon the precautionary principle in its policy making, it should publicly state: a) how the controlled activity meets its specified conditions for recourse to the precautionary principle; b) how measures adopted in response align with the general principles of risk management (described above), and c) what is being done to resolve uncertainties and render continued precautionary measures unnecessary.***

103. ***We remind the Commission that any legislation guided by the precautionary principle must allow for an exit from precautionary measures once there is strong scientific consensus that any risks are low.***

Responding to uncertainty

104. As the above evidence indicates, Sir Mark's claim that the precautionary principle has, in some instances, acted as "a red stop light in front of innovation" appears to be borne out in the case of EU GMO regulation.[345] In part, this appears to be due to a lack of clarity and consistency in its interpretation and application. However, appropriate use of the precautionary principle also appears to be confounded by another factor: a blurring of scientific and other forms of uncertainty.

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341 European Commission, Communication from the Commission on the precautionary principle, COM(2000)1, February 2000, para 6.3

342 See, for example, GMC037 [ADHB] para 9, GMC029 [SCIMAC] exec summary, GMC027 [Professor Baulcombe] para 3 and GMC013 [Professor Pollock] exec summary

343 See, for example, Q418 [Professor Hails]; Q22 [Professor Leyser]

344 See, for example, Q318 [Professor Perry]

345 Q288

105. As previously stated, in 2005 the UN World Commission on the Ethics of Scientific Knowledge and Technology described the precautionary principle as the belief that:

> When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm.[346]

This definition, like several others,[347] hinges on the presence of *scientific* uncertainty. However, even when scientific uncertainty has been largely resolved, other forms of uncertainty can remain. According to Professor Andy Stirling, University of Sussex, value-based uncertainties—or "ambiguities"—can arise "even for events that are certain or have occurred already": in the case of genetically modified foods, for example, "ambiguities arise over ecological, agronomic, safety, economic or social criteria of harm", which are independent of scientific questions of relative risk.[348] Several witnesses argued that the EU's use of the precautionary principle had been driven by political concerns associated with these areas of ambiguity rather than by genuine scientific uncertainty. Dr Julian Little, Agricultural Biotechnology Council, referred to the case of maize 1507 (see box 5), in which he argued that the precautionary principle had been used to undermine science-based risk assessment "as a way of stopping this [product] getting to the market".[349] Dr Paul Burrows, Biotechnology and Biological Sciences Research Council, stated that "if the [European] Commission is applying the precautionary principle" to genetically modified crops, then "personally, I do not think it is applying it because of the science".[350] The Government and its Chief Scientific Adviser appeared to have similar concerns. Sir Mark stated that the principle had become "politicised with a small 'p'" and the Minister agreed that "the idea of precaution" was being "misused to block or deter innovations such as GM, which are politically controversial" and that the EU's "misuse of the precautionary principle" was "one instance" of "a poor approach to the formulation and implementation of science-based regulation".[351]

106. The evidence that we received suggested that the source of uncertainty about a given technology—and the extent to which it is science-based, as opposed to value-based—is key to establishing whether or not continued recourse to the precautionary principle is appropriate.[352] According to the Science Council:

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346 United Nations Educational, Scientific and Cultural Organization, World Commission on the Ethics of Scientific Knowledge and Technology, *The Precautionary Principle*, March 2005, p.14

347 For example: that of the European Commission (precaution is appropriate in "those specific circumstances where scientific evidence is insufficient, inconclusive or uncertain", see paragraph 96), the Rio Declaration ("lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation"), the Cartagena Protocol on Biosafety (which draws on the Rio definition), and the UN Framework Convention on Climate Change ("where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing" measures to "anticipate, prevent or minimise the causes of climate change and mitigate its adverse effect").

348 Andrew Stirling "Risk, precaution and science: towards a more constructive policy debate", *EMBO reports*, vol 8 (2007), pp.310

349 Q187 [Dr Little]

350 Q165

351 Q291; Q471; GMC051 [Gov] para 38

352 See also Andrew Stirling "Risk, precaution and science: towards a more constructive policy debate", *EMBO reports*, vol 8 (2007), pp.309-315

> The precautionary principle is […] usefully applied when there remains uncertainty or no scientific consensus about the level of risks around a product or process. But when there is strong scientific consensus that the same product or process is considered to be low-risk then the precautionary principle is logically obsolete.[353]

Professor Stirling stated that the precautionary principle "comes into its own" under those "more intractable states of incertitude" where risk assessment is unable to provide a rational basis for decision-making.[354] While risk assessment can be a valid response to scientific uncertainty, Professor Stirling argued that it was "misleading to claim that single definitive science-based decisions"—such as those derived from risk assessment—were possible in such situations and suggested that other approaches, such as "substantive public engagement", offered an alternative approach to understanding and responding to these types of uncertainties.[355]

107. Several other witnesses also highlighted the importance of public engagement as an alternative response to uncertainty. The Royal Society stated that "public and stakeholder dialogue should be a part of all" risk governance frameworks and Sir Roland Jackson, Nuffield Council on Bioethics, agreed that "public engagement and […] wider stakeholder engagement" had "quite a role to play".[356] In its recent report on *Emerging biotechnologies*, the Nuffield Council on Bioethics also strongly emphasised the moral value of public discourse. According to this report, the "significant public interest" arising from emerging biotechnologies (such as advanced genetic breeding techniques) means that they should be subject to a "public ethics", based on securing public good, rather than a more "individualistic ethics that attempts only to protect the freedoms of individuals in ways compatible with the freedom of others within a society".[357] The report argued that, while "in a plural society there will not be a single vision of the public good that can be applied in all circumstances", the construction of a public discourse based on certain procedural and institutional virtues[358] could offer a "practical way of responding collectively" to the challenges posed by emerging biotechnologies through "'public' decision making, orientated by pursuit of the public good".[359]

108. Various models intended to more formally incorporate public and stakeholder engagement into the risk analysis process have been developed. One of these is the International Risk Governance Council's *Risk Governance Framework*, which modifies the traditional three-stage risk analysis process (risk assessment, risk management, risk

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353 GMC047 [Science Council] para 5.4

354 Andrew Stirling "Risk, precaution and science: towards a more constructive policy debate", *EMBO reports*, vol 8 (2007), pp.312

355 Andrew Stirling, "Opening Up the Politics of Knowledge and Power in Bioscience", *PLoS Biology*, volume 10 (2012), p.4

356 GMC044 [Royal Society] para 5; Q227 [Sir Roland Jackson]

357 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and the public good*, December 2012, para 17; executive summary, chapter 4 overview

358 The report defined these virtues as openness and inclusion, accountability, public reasoning, candour, enablement and caution. Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and the public good*, December 2012, para 23

359 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and the public good*, December 2012, para 23; executive summary, chapter 4 overview

communication) to include two additional stages: "risk pre-assessment", in which different potential framings of the problem are considered, and "characterisation and Evaluation", in which scientific data are considered alongside societal factors in order to evaluate whether the risk is "acceptable, tolerable (requiring mitigation), or intolerable (unacceptable)".[360] Professor Joyce Tait, Innogen Institute, described this framework as "quite an advanced approach to looking at these kinds of questions where value judgment comes into play".[361] Similarly, the final report of the EU-funded *Safe Foods Initiative* offered a structured approach to the assessment and management of food safety threats in which framing and consideration of societal factors played a more formalised role than is typical in current approaches.[362]

109. **We have already acknowledged the considerable relevance of societal concerns to decision-making about risk and reiterate the need for non-scientific factors to be considered alongside scientific risk assessment during the risk governance process. However, the precautionary principle was designed primarily as a response to scientific uncertainty, not value-based ambiguity. Such ambiguities are common in emerging areas of science and technology and are also often intractable; recourse to the precautionary principle in these scenarios would therefore potentially act as a permanent barrier to the use of safe innovations. Where value-based ambiguities exist, public discourse, not scientific risk assessment, should be pursued as a route to greater legitimacy.**

110. ***We recommend that the Government give greater consideration to the value that participatory processes might contribute to its own treatment of risk and uncertainty in policy development. We particularly refer the Government to the*** **Risk Governance Framework** ***and*** **Safe Foods Initiative** ***and ask it to set out how the perspectives offered by these documents will inform its future approach to risk governance policy.*** The next chapter gives further consideration to the subject of public information and discourse.

Government use and interpretation of the precautionary principle

111. Our interpretation of the precautionary principle is broadly in line with both the stated position of the European Commission (see paragraph 95) and that of the UN's World Commission on the Ethics of Scientific Knowledge and Technology, which stipulates that the principle should be applied where the risk of "morally unacceptable harm" is "scientifically plausible but uncertain".[363] However, the Government Chief Scientific Adviser, Professor Sir Mark Walport, offered a somewhat different interpretation. In an April 2013 opinion piece in the *Financial Times*, Sir Mark framed the precautionary principle not as a response to scientific uncertainty, but as a guide to evidence-based decision-making. According to Sir Mark:

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360 International risk governance council, 'IRGC risk framework', irgc.org, accessed 26 January 2015.

361 Q258 [Professor Tait]

362 Marion Dreyer, Ortwin Renn, Adrian Ely, Andy Stirling, Ellen Vos and Frank Wendler, 'A General Framework for the Precautionary and Inclusive Governance of Food Safety in Europe', Final Report of subproject 5 of the EU Integrated Project SAFE FOODS, June 2008.

363 United Nations Educational, Scientific and Cultural Organization, World Commission on the Ethics of Scientific Knowledge and Technology, *The Precautionary Principle*, March 2005, p.14

> Decisions must be informed by the best evidence and expert advice. The application of the "precautionary principle" can help to guide this. This simple idea just means working out and balancing in advance all the risks and benefits of action or inaction, and to make a proportionate response. All too often, people citing this principle simply overreact: if there is any potential hazard associated with an activity, then it should not be done, or, if it is already being done, it should be stopped.[364]

Sir Mark described the precautionary principle to us in similar terms during this inquiry, stating that the principle "basically" means: "Do a full evaluation of the science before you make a decision" and "think about the consequences of both action and inaction".[365] The Minister stated that he "broadly agree[d]" with this definition and, like Sir Mark, stressed that the principle required that "a full science-based evaluation" be carried out before a decision be made.[366] In his first annual themed report, *Innovation: managing risk, not avoiding it*, Sir Mark expressed concern about an apparent "drift of interpretation of the precautionary principle from what was, in effect, a holding position pending further evidence, to what is now effectively a stop sign".[367] However, despite focusing heavily on the subjects of innovation, risk and uncertainty, this report contained no specific recommendations about how the principle might be more systematically applied.

112. Sir Mark's argument that the precautionary principle requires "all the risks and benefits of action or inaction" to be "work[ed] out and balanc[ed] in advance"[368] could be seen to vary significantly from those definitions that place the existence of scientific uncertainty at their centre.[369] In a chapter in the supporting case studies for Sir Mark's annual themed report, Professor Andy Stirling, University of Sussex, stated that although the precautionary principle "comes in many forms, a classic general expression of precaution is that scientific uncertainty is not a reason for inaction in preventing serious damage to human health or the environment".[370] He continued:

> By explicitly hinging on uncertainty rather than risk, precaution helps to promote recognition that social choices in innovation are not reducible to ostensibly precise, value-free, technical risk assessments.[371]

In another 2013 opinion piece, commentator George Monbiot criticised Sir Mark for his "misunderstanding of the precautionary principle"—a concept that he considered to be

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364 "*There is no easy solution to the problem of the bees*", Financial Times, 26 April 2013, accessed 26 January 2015.

365 Q288

366 Q471

367 Government Office for Science, Innovation: managing risk, not avoiding it, Annual Report of the Government Chief Scientific Adviser, November 2014, p.8

368 "*There is no easy solution to the problem of the bees*", Financial Times, 26 April 2013, accessed 26 January 2015.

369 For example, that of the United Nations World Commission (paragraphs 49), the European Commission (paragraph 95)

370 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.59.

371 Government Office for Science, *Innovation: managing risk, not avoiding it*, Evidence and Case Studies, 'Chapter 4: Making choices in the face of uncertainty: strengthening innovation democracy', November 2014, p.59.

"fundamental to Walport's role" as Chief Scientific Adviser.[372] He rejected Sir Mark's focus on scientific evaluation and compared this with the definition of the precautionary principle offered by the Rio Declaration:

> where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.[373]

Science policy experts Professor Roger Pielke Jr and James Wilsdon defended Sir Mark against Monbiot's claim that he had "misinformed the public about the scientific method, risk and uncertainty",[374] but stated that it was "fair to criticise Walport for a rather lazy caricature of the precautionary principle".[375]

113. **The Government recognises the importance of properly understanding and applying the precautionary principle, but it is not clear that it has done so. Government explanations emphasise the need for decisions made under the guidance of the precautionary principle to be based on a "full science-based evaluation", but fail to recognise that such evaluations are often impossible in those circumstances when precaution is most needed—that is, in situations of scientific uncertainty or ignorance. The Government Chief Scientific Adviser's first annual themed report, on the subject of innovation and risk, has done little to clarify this situation. *The Government should prepare a short document, informed by wider consultation, detailing its understanding of the principle and the circumstances in which it intends to use the precautionary principle as a guide to policy making. This should be made publicly available by the end of 2015.***

372 "*Beware the rise of the government scientists turned lobbyists*", Guardian Online, 29 April 2013, accessed 26 January 2015.

373 "*Beware the rise of the government scientists turned lobbyists*", Guardian Online, 29 April 2013, accessed 26 January 2015

374 "*Beware the rise of the government scientists turned lobbyists*", Guardian Online, 29 April 2013, accessed 26 January 2015

375 "*Why Monbiot's attack on Walport misses the mark*", Guardian Online, 30 April 2013, accessed 26 January 2015

6 Public information and discourse

114. This chapter focuses on how the public debate about genetic modification has been framed, how it has evolved, and how a more productive conversation about science and technology in general, and food and farming in particular, might be initiated in the UK.

Public debate and 'GM': a brief history

115. Several public engagement initiatives focused on agricultural biotechnology, specifically genetic modification, have taken place in the UK over the last 20 years. The first of these, in 1994, was a three-day 'consensus conference' on plant biotechnology. Over the course of this three-day "experiment in democracy", a panel made up of 16 lay volunteers selected and took evidence from a variety of witnesses, before delivering a "verdict" that offered its "qualified support" to the technology.[376] The panel advocated close regulation and clear labelling of genetically modified plants, but concluded that:

> there is scope for people to intervene in controlled ways which have the potential to provide significant benefits, and at the same time to satisfy the requirements of those people who feel that matters are progressing too quickly with an implied lack of care.[377]

A decade later, another unique public engagement exercise, the "unprecedented" UK-wide *GM Nation?* debate, reached a far less optimistic conclusion, suggesting that people were "generally uneasy" about GM and finding "little support for the early commercialisation of GM crops".[378] However, the debate was widely criticised: according to an independent evaluation, it suffered from "a number of important flaws in terms of both design and implementation", which potentially led to an overestimation of the level of outright opposition to GM.[379] Nevertheless, the debate was influential: in its response to the exercise, the Government stated that it took "public concern very seriously" and had "weighed public opinion alongside the scientific evidence" in its policy development, promising to "protect human health and the environment through robust regulation of GM crops on a case-by-case basis, consistent with the precautionary principle".[380]

116. The challenges and potential pitfalls of public debate about this issue, highlighted by *GM Nation*, came to the fore once again in 2009, when, at the request of the Government, the Food Standards Agency (FSA) announced that it would carry out "a programme of consumer engagement on GM food and other emerging [food] technologies".[381] An

376 UK National Consensus Conference on Plant Biotechnology, *Final report of the lay panel*, November 1994

377 UK National Consensus Conference on Plant Biotechnology, *Final report of the lay panel*, November 1994

378 Department of Trade and industry, 'GM Nation: the findings of the public debate', September 2003. Note: this report is not available online.

379 Tom Horlick-Jonesa, John Walls, Gene Rowe, Nick Pidgeon, Wouter Poortingae and Tim O'Riordan, "On evaluating the GM Nation? Public debate about the commercialisation of transgenic crops in Britain", *New genetics and society*, vol 25 (2006) pp.265-288. DOI:10.1080/14636770601032858

380 Department for Environment, Food and Rural Affairs, 'The GM Dialogue: Government Response', March 2004, para 1

381 Food Standards Agency, 'Chief Executive's Report: September 2009', September 2009, para 3

independent steering group consisting of "public dialogue specialists and people involved in different areas of GM and with different views on the subject" was set up to "inform and shape" the project and make "key decisions about how the dialogue is designed and delivered".[382] In June 2010, members of this steering group, Professor Brian Wynne, Professor of Social Sciences at the University of Lancaster, and Helen Wallace, Director of GeneWatch UK, resigned due to what Professor Wynne called the FSA's "pro-GM policy stance".[383] Professor Wynne criticized the "narrow" way in which the dialogue had been framed, arguing that:

> if no one challenges the institutional dogma […] that the issues are scientific and the only perspective which can be properly used to assess these is (so-called) 'sound science', then these wider frameworks will be doomed to dismissal before they have been properly heard.[384]

The resignations generated significant media coverage and in September 2010 the then Science Minister, David Willetts MP, announced that the planned dialogue project would "not continue in its current format".[385] Mr Willetts explained that the Government was instead "taking this valuable opportunity to step back and review past dialogues on GM and other areas of science to ensure we understand how best to engage the public over such issues".[386]

117. Since the collapse of the planned FSA project in 2010, no further Government-led dialogue on genetic modification, agricultural biotechnology or food technology more generally has taken place. However, survey results suggest that views have evolved since the 2003 *GM Nation* debate. George Freeman MP, Minister for Life Sciences, provided a summary of some of this evidence:

> The Institute of Grocery Distribution, as you will be aware, do periodic surveys. They report this year that most UK consumers now describe themselves as neutral towards GM foods, whatever is meant by that. The FSA tracker survey suggests that GM is now of less concern to consumers than it was some time ago, and the 2014 Public Attitude to Science Survey reported that more people think that the benefits of GM crops now outweigh the risks. These are tentative data, but I think they suggest […] that we have to continually reassure but also promote the benefits [of genetic crop technologies]. I think that the public and consumers see the problems and they will begin to support this whole area more, provided they are reassured and understand them.[387]

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382 Food Standards Agency, 'Food: The use of GM: a public dialogue', August 2011, accessed 26 January 2015.

383 "*Academic quits GM food committee*", BBC News Online, 3 June 2010, accessed 26 January 2015.

384 Correspondence from Professor Brian Wynne to Professor John Curtice, Chair, FSA Public Dialogue Steering Committee, 31 May 2010. Available at GeneWatch, 'GeneWatch PR: New GM dialogue resignation welcomed', genewatch.org, accessed 26 January 2015.

385 Sciencewise, 'Announcement by Science Minister on GM public dialogue', September 2010, accessed January 2015.

386 Sciencewise, 'Announcement by Science Minister on GM public dialogue', September 2010, accessed January 2015.

387 Q470 [George Freeman MP]

Similar conclusions were drawn by Dr Jack Stilgoe, University College London, who "strongly agreed" that survey data suggested "ambivalence within the general public" on this subject and Síle Lane, Sense about Science, who stated that "GM" was "just not high on people's agenda".[388]

Initiating a new debate

118. As the outline above indicates, the public debate about technological advances in plant science has long been centred on the notion of 'GM' and, often, the question of whether or not it is 'safe'. However, according to Sciencewise, although anxieties about safety are the "entry point" for many people's understanding of such technologies, "these concerns are the start of the discussion rather than the end".[389] A Sciencewise review of past public dialogue exercises suggested that other common concerns about 'GM' include: its perceived novelty; uncertainty about its impact on complex ecosystems; potential socio-economic issues related to corporate control of GM assets, and a general lack of confidence in the ability of scientists, companies and governments to "understand and regulate the myriad possible implications of new science and technology".[390] This lends weight to the claim made by Dr Paul Burrows, Biotechnology and Biological Sciences Research Council, that "GM has become a lightning rod for many other issues—about fairness, access and corporate control of the food system".[391]

119. The extent to which this technology has become the focus of broader ideological concerns about the agricultural system is also reflected in the explanations given to us by those opposed to genetic modification. While citing the "safety" of genetically modified crops as a concern, Liz O'Neill, GM Freeze, referred repeatedly to the "commercial environment" surrounding these products and the "control" conferred on large multinationals by the patent system.[392] She stated that the "one absolute position" that her organisation held was that "genetic resources are a public good and should not be owned by anybody".[393] Peter Melchett, Soil Association, couched his organisation's position in similar terms, stating that "organic standards are not based simply on science" and arguing that "the values of the people who buy organic food would not accept GM in organic [farming]".[394] Professor Andy Stirling, University of Sussex, saw no problem with such arguments, characterising them as a "legitimate expression[s] of concern" that are often unfairly characterised as "ideological opposition" when applied to new technologies.[395] However, Professor Leyser, Royal Society, argued that channelling such concerns into a single technology area could be damaging:

> GM has attracted, as a magnet, all the issues that people are concerned about in agriculture. They are real and important issues, but none of them has

388 Q58

389 Sciencewise, 'Talking about GM: Approaches to Public and Stakeholder Engagement', September 2011, p.3

390 Sciencewise, 'Talking about GM: Approaches to Public and Stakeholder Engagement', September 2011, pp.3-4

391 Q165

392 Q7

393 Q4

394 Q123

395 Q250 [Professor Stirling]

> anything to do with the technique. As a result of the absurd focus on GM, we are ignoring all these broader issues, and the problems that we would like to address are going unaddressed because everybody is banging on about GM.[396]

120. Several witnesses emphasised the need to reframe the public debate in order to consider this contested group of technologies in the wider setting of other plant breeding techniques and the wider issue of food security. Síle Lane, Sense about Science, stated that the "framing of the subject is what forms people's opinions" and, in the case of genetic modification, the technology had been taken "out of context" and was not seen as "one of a suite of plant breeding techniques" as it should be.[397] Sir Roland Jackson, Nuffield Council on Bioethics, agreed with the need for this contextual frame to be widened, stating that "if you have a major issue like this in a democracy, one of the solutions is to reframe the problem and look at it from a different and broader angle"; that is, "in the context of global food supply and global food security".[398] Professor Rosemary Hails, Advisory Committee on Releases to the Environment, stated that there was a need to initiate "a debate about what farming systems are going to deliver what suite of benefits" in the future: a debate that "GM" forms "a very small part of".[399]

121. **The term 'GM' has become a lightning rod for much broader public anxiety, in particular regarding our environmental future and the level of control wielded by large multinationals. These are legitimate concerns, but are currently centred on an inappropriate target. Whether a GM product is 'good' or 'bad', either for the environment or for society more broadly, should focus more clearly on how it is used than the technology utilised to produce it. This fact is lost in the continuing focus on 'GM'. There is a need to reframe and widen the public debate to encourage a more productive conversation about what we, as a society, want from our food supply and what sort of agriculture we would like that supply to be based upon.**

We see two main drivers for achieving this: improving the quality and nature of the information available to the public and initiating a wider, more participatory debate.

Public information

122. Science communication experts accept that improved public understanding of science does not inevitably lead to greater support for the fruits of its labour. What's more, any attempt to neutrally inform the public is invariably tainted by value-laden framings and assumptions and even the very concept of a single indiscriminate 'public' is problematic. Nevertheless, public dialogue is predicated on the notion that participants have some understanding of what is being debated and evidence suggests that, in the case of genetic modification and many other areas of science and technology, there is both and a need and a desire for the public to be more fully informed.

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396 Q22 [Professor Leyser]

397 Q60 [Síle Lane]

398 Q236 [Sir Roland Jackson]

399 Q439 [Professor Hails]

123. A key finding of the 2003 *GM Nation* debate was that people felt that they did "not have enough reliable, independent information to make up their minds" about genetic modification.[400] The debate highlighted a "broad desire" from participants "to know more" and "a very strong wish—almost a longing" to be "better informed about GM from sources they could trust".[401] More recent evidence echoes these findings. Sue Davies, Chief Policy Adviser for *Which?*, told us that "a lot of people feel that they need more information" about genetic modification, and about "new technologies more generally".[402] According to Jon Woolven, Strategy and Innovation Director at the Institute of Grocery Distribution (IGD), IGD research indicates that "even now after all the publicity on this topic, only 20% of people feel they have a good understanding of GM" and "only about three quarters of those people give a definition that we feel comes anywhere close".[403] He considered "lack of public understanding" to be "the single biggest issue" underlying consumer attitudes to genetically modified crops.[404] Evidence suggests that a better understanding of the benefits of genetic technologies could be an important influence on public opinion. A 2014 YouGov survey found that only 22% of respondents thought that the Government should be "promoting the adoption of GM technology in the UK".[405] However, a 2012 survey commissioned by *The Independent*, which framed the technology in terms of its potential agricultural benefits, found that 64% thought that "experiments to develop GM crops should be encouraged by government" if this would enable farmers to "reduce the amount of pesticides they use".[406]

124. **Evidence suggests that members of the public currently find it difficult to develop an informed opinion about whether or not they support technologies such as genetic modification. This needs to change if there is to be meaningful public debate and if future policy is to be usefully informed by the insights that such debate can bring.**

We have briefly considered the role of some of the most important sources of public information and offer some suggestions as to how they might better support informed debate.

The BBC

125. According to the most recent Public Attitudes to Science survey, the traditional media remain the most regular source of public information about science (see figure 2). Over half (59%) of respondents said that television was "one of their two most regular sources of information on science, either in the form of TV news programmes (42%) or non-news programmes (26%)", with print newspapers the third most common source of information.[407] A particularly important source of public information is the BBC. Under

400 Department of Trade and industry, 'GM Nation: the findings of the public debate', September 2003

401 Department of Trade and industry, 'GM Nation: the findings of the public debate', September 2003

402 Q80 [Sue Davies]

403 Q80 [Jon Woolven]

404 Q81 [Jon Woolven]

405 YouGov, 'Many in Britain still sceptical of GM foods', 21 February 2014, accessed 26 January 2015

406 GMC046 [Society of Biology] para 6; ComRes Opinion Poll, June 2012.

407 Department for Business, Innovation and Skills/Ipsos Mori, 'Public attitudes to science 2014', Main Report, March 2014, p.54

the terms of its Royal Charter, the BBC has a responsibility to "promote education and learning".[408] It aims to do this by stimulating "informal learning across a full range of subjects and issues", engaging audiences in "activities targeted to achieve specific outcomes that benefit society" and promoting and supporting "formal educational goals".[409]

126. In our 2014 report, *Communicating climate science*, which closely considered the quality of BBC science coverage, we found "the role of the BBC, as the leading public service broadcaster, to be central to public understanding" of climate science, but were "disappointed to find it lacked a clear understanding of the information needs of its audience" in relation to this controversial topic.[410] We also highlighted concerns about the BBC's pursuit of impartiality potentially leading to "false balance" and stated that while "scientists, politicians, lobbying groups and other interested parties should be heard" on controversial topics, "the BBC should be clear on what role its interviewees have and should be careful not to treat lobbying groups as disinterested experts".[411]

127. **We have performed no detailed study of BBC coverage for this inquiry; however, we again emphasise the central role that the BBC plays in communicating science and remind it of its responsibility, as a public sector broadcaster, to promote learning and encourage conversation and debate about this important topic. *We encourage all of the media, particularly public broadcasters, to conduct a review of their own content on genetic modification, 'GM' and other related topics to ensure that it is fulfilling these public duties. In particular, consideration should be given to how this topic is framed and whether it is being considered broadly enough in the context of other agricultural methods and wider issues of food production and food security.***

Non-governmental organisations

128. In its 2013 advice to the Prime Minister, the Council for Science and Technology stated that those providing information to the public on genetic modification, "including retailers, NGOs and the media", had "a duty to ensure that the debate reflects the evidence accurately".[412] This is not being heeded by some prominent non-governmental organisations. Examples of statements that appear to deliberately misrepresent the available evidence regarding the safety of genetically modified organisms include the following:

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408 Department for Culture, Media and Sport, *Royal Charter for the continuance of the British Broadcasting Corporation*, Cm 6925, October 2006, article 4(b)

409 BBC, 'Inside the BBC: public purposes—promoting education and learning', accessed 26 January 2015

410 Science and Technology Committee, Eight report of session 2013-14, *Communicating climate science*, HC254, April 2014, summary

411 Science and Technology Committee, Eight report of session 2013-14, *Communicating climate science*, HC254, April 2014, paras 34 & 42

412 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015.

- "GMOs should not be released into the environment since there is not an adequate scientific understanding of their impact on the environment and human health" (Greenpeace International);[413]

- "GM represents probably the biggest uncontrolled experiment ever conducted by humans. […] Our direct consumption of GM food, but also our indirect consumption of it via animals that have in turn been fed GM feed, poses very serious risks to human health and the environment" (Alliance for Natural Health);[414]

- "GM food has failed to deliver on the industry's promises. It hasn't tackled hunger or helped most of the world's farmers. Contamination of our food is rising, the environment is under threat and long-term health impacts are still unknown. With safe alternatives like sustainable, organic farming we simply don't need GM" (Friends of the Earth);[415]

- "GM crops have the potential to cause massive social, economic and environmental damage worldwide, yet they are poorly tested and regulations are weak" (GM Freeze).[416]

As we have demonstrated elsewhere in this report, claims that genetically modified crops pose inherent environmental and health risks, are weakly regulated or have undergone little research are not supported by the available evidence.[417]

129. **We are each entitled to our own opinion and value-based opposition to genetic modification, or any other technology, is perfectly legitimate. However, this does not justify knowingly and willingly misinforming the public.** ***We strongly urge those seeking to inform the public about genetic modification and other advanced genetic plant technologies to provide an honest picture of the scientific evidence base and the regulatory controls to which these products are currently subject. Where opposition to such technologies is value-based, this should be openly acknowledged and should not be concealed behind false claims of scientific uncertainty and misleading statements regarding safety.***

130. The role of non-governmental organisations in shaping debate can be demonstrated through the example of so-called 'golden rice'. Golden rice is a transgenic rice variety genetically modified to contain beta carotene, a precursor to vitamin A and a naturally occurring pigment common to many fruit and vegetables, including carrot, papaya and squash.[418] It was developed by public-sector scientists in the late 1990s as a potential remedy for vitamin A deficiency, a major cause of preventable blindness in developing countries. According to the World Health Organisation, "an estimated 250 million

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413 Greenpeace, 'Genetic engineering: What's wrong with genetic engineering?', greenepace.org, accessed 26 January 2015

414 Alliance for Natural Health, 'Say No to GM', accessed 26 January 2015

415 Friends of the Earth England Wales and Northern Ireland, 'What's on your plate? GM food—it hasn't gone away', accessed 26 January 2015

416 GM Freeze, 'Why a freeze?', gmfreeze.org, accessed 26 January 2015

417 See paragraph 47 and paragraphs 59-61

418 Beta carotene is what gives these foods—and golden rice—their distinctive golden colour.

preschool children are vitamin A deficient" and "250,000 to 500,000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight".[419] According to the Royal Society:

> The first generation of golden rice varieties contained only low levels of b-carotene and there was some scepticism as to whether their introduction would mitigate vitamin A deficiency and benefit poor, rice-dependent households. However, there are now lines with much higher levels of b-carotene and good evidence from clinical trials that it is an effective source of vitamin A.[420]

International Rice Research Institute, a non-profit research organisation and the lead for the global 'Golden Rice Project', states that "golden rice is undergoing rigorous safety evaluations by regulators throughout its development" and "will be available to farmers and consumers only after it has been determined to be safe for humans, animals, and the environment and authorized for propagation and consumption by the appropriate regulatory authorities".[421]

131. Greenpeace actively campaigns against the use of golden rice, stating on its website that golden rice is "environmentally irresponsible, poses risks to human health, and could compromise food, nutrition and financial security".[422] Dr Parr presented his organisation's opposition to us in somewhat less absolute terms:

> My take on golden rice is that it is a last resort. It is the least favourable option, given the challenges of nutrition across the spectrum. […] People who are on the ground dealing with this in the Philippines see the focus and attention on golden rice acting as a disincentive to dealing with some of the other more serious and crosscutting issues. […] It is a stop-gap and a sticking plaster for a much deeper problem.[423]

In an interview of BBC Radio 4's *Today* programme in October 2014, Dr Parr stated that "the real solution" to vitamin A deficiency was to provide people with access to "a proper balanced diet".[424] He acknowledged that "biofortification"—that is, increasing the nutritional value of crops through biological means, such as conventional or advanced breeding techniques—might be "appropriate" under "certain circumstances" in which more comprehensive solutions could not be delivered quickly, but insinuated that "other biotechnologies, like marker-assisted breeding" could offer an alternative to golden rice.[425] However, Professor Sir David Baulcombe, University of Cambridge, stated that there was "no way that you could use marker-assisted breeding to produce a variety that has the

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419 World Health Organisation, 'Nutrition: micronutrient deficiencies', who.int, accessed 26 January 2015

420 The Royal Society, *Reaping the benefits*, October 2009, para 3.3.6.2

421 International Rice Research Institute, 'Frequently asked questions on Golden Rice', accessed 26 January 2015

422 Greenpeace, 'What we do: Golden Rise', accessed 26 January 2015

423 Q18

424 Doug Parr, *Today Programme*, BBC Radio 4, 15 October 2014. Transcript via mytranscriptbox, accessed 27 January 2015.

425 Doug Parr, *Today Programme*, BBC Radio 4, 15 October 2014. Transcript via mytranscriptbox, accessed 27 January 2015.

nutritional benefits of golden rice" and added that the reason why there was so much emphasis on golden rice was "because of the resistance to it" by organisations such as Greenpeace.[426] Mark Cantley, an ex-employee of the European Commission's Directorate-General for Research, described such campaigns as "wicked" and claimed that they were the "driven by exaggerated 'environmental' concerns" and "a casual attitude to deaths and disabilities caused elsewhere in the world".[427] The former Environment Secretary, Owen Patterson MP, similarly characterised such opposition to golden rice as "wicked" in an interview 2013.[428]

132. **We question the basis for Greenpeace's opposition to golden rice—a crop that is undergoing rigorous safety evaluations and has the potential to help protect many hundreds of thousands of children in the developing world from preventable blindness and early death—and question its public claim that this crop is "environmentally irresponsible" and "poses risks to human health". We recognise that biofortification cannot replace a balanced diet but remind those who oppose golden rice that the best should not be the enemy of the good.** ***We urge those organisations that actively campaign against the take-up of golden rice in other regions of the world to carefully consider how this position impacts on their professed humanitarian aims. We recommend that all such organisations—and specifically Greenpeace—review their public communication materials to ensure that they are evidence-based and honest in setting out the reasons for opposition to this technology.***

The Government and its agencies

133. Evidence suggests that the Government, its advisers and its agencies are also susceptible to a narrow and, on occasion, misleading framing of advanced genetic approaches. The Department for Environment, Food and Rural Affairs' policy pages on GOV.UK include a section focused on "genetic modification", which contains no mention of the Government's policy on other breeding techniques or other types of novel crop.[429] Another page includes a section on "controlling cloning and genetic modification", framing the Government's policy on genetic modification in the context of the more controversial and novel technology of animal cloning.[430] This framing of 'GM' in terms of its 'novelty' continues across the Government's scientific advisory structure. Professor Guy Poppy, Chief Scientific Adviser to the Food Standards Agency (FSA), stated that he did not think that "GM" should be "singled out" in the FSA's communications with the public.[431] However, the science and policy pages of the FSA website currently lists "GM foods" as a specific category of "novel food", alongside "nanotechnology" and, once again, "cloned

426 Q19 [Professor Baulcombe]

427 GMC011 [Mark Cantley]

428 "GM "golden rice" opponents wicked, says minister Owen Paterson", BBC News Online, 14 October 2013, accessed 27 January 2015.

429 Department for Environment, Food and Rural Affairs, 'Policy: Making the food and farming industry more competitive while protecting the environment', *Detail: genetic modification*, last updated 14 November 2014, accessed 27 January 2015.

430 Department for Environment, Food and Rural Affairs, 'Policy: Making the food and farming industry more competitive while protecting the environment', *Policy*, last updated 14 November 2014, accessed 27 January 2015.

431 Q438 [Professor Poppy]

animals".[432] When asked why advanced genetic approaches had been framed in this way, Professor Poppy acknowledged that this was a "good question" but explained that "GM" had been placed in the context of these other technologies because "they are probably the modern technologies that people have heard of and which [consumers] would bring to our attention".[433] The titles of the recent work by the Council for Science and Technology—a "GM Science update" and a letter to the Prime Minister on the subject of "GM technologies"—were also narrowly framed, although the content included a much broader consideration of advanced genetic approaches and their agricultural contexts.[434]

134. The role of the Government's framing of "GM" in perpetuating old debates is perhaps best illustrated by an example. In her recent appearance at the Oxford Farming Conference, Liz Truss MP made her first public mention of "GM" in her role as Secretary of State.[435] In her speech, Ms Truss stated that she had called for EU decisions on "issues like pesticides and GM cultivation to be made on scientific evidence alone", commenting afterwards that "GM crops have a role to play" in the UK.[436] A headline from the following day's *Mail Online* ran as follows:

> 'Eco-friendly' Frankenfoods should be grown in Britain, says Minister, as she backs controversial technology for first time.[437]

135. **By constantly framing genetic modification alongside other novel, controversial or potentially harmful technologies (for example, nanotechnology, animal cloning and pesticides), the Government encourages the public to understand genetic modification in the same terms. By failing to widen its framing beyond the narrow concept of 'GM', the Government also perpetuates old debates and preserves the perceived distinction between genetically modified and conventionally bred plants. Finally, by publicly insisting that decisions about this technology be made on the basis of scientific advice alone, the Government shuts down opportunities for wider debate and encourages those who are simply opposed to the technology to continue to contest the science. *We recommend that both the Government and the Food Standards Agency review their public communications on genetic modification and related topics to ensure that these are framed in a way that encourages constructive public debate. Advice on this process should be sought from the Sciencewise expert resource centre and identified changes should be made by the end of 2015.***

136. The notion that genetically modified crops are inherently dissimilar to other types of crop is also built into the Government's scientific advisory structure itself. The Advisory

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432 Food Standards Agency, 'Science and policy: Novel foods', accessed 27 January 2015

433 Q439

434 David Baulcombe, Jim Dunwell, Jonathan Jones, John Pickett and Pere Puigdomenech, *GM science update: a report to the Council for Science and Technology*, March 2014; Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013.

435 Department for Environment, Food and Rural Affairs, *Environment Secretary speech at the Oxford farming conference*, published 7 January 2015, accessed 26 January 2015

436 Department for Environment, Food and Rural Affairs, *Environment Secretary speech at the Oxford farming conference*, published 7 January 2015, accessed 26 January 2015; "Britain must be free to grow GM food, says Minister", The Times, 8 January 2015, accessed 26 January 2015

437 "Eco-friendly" Frankenfoods should be grown in Britain, says Minister, as she backs controversial technology for first time', Mail Online, 8 January 2015, accessed 27 January 2015

Committee on Releases to the Environment (ACRE) has acknowledged that the "environmental consequences" of cultivating a particular crop are unlikely to be affected by "the techniques used for trait manipulation" and has strongly advocated a move to a trait-based regulatory system.[438] However, its own remit limits its advice primarily to those crops produced via genetic modification.[439] According to Professor Rosemary Hails, ACRE Chair, ACRE's primary role is to "provide advice on the risk that GMOs pose to the environment and to human health in the context of environmental exposure".[440] She continued:

> We do not do food and feed safety or contained use; that is covered elsewhere. We also do not look at plants or organisms used in agriculture or veterinary medicine that are not produced by genetic modification. Occasionally we are also asked to provide advice to DEFRA on non-native organisms. That is a non-statutory role.[441]

Professor Hails acknowledged the "illogicality" of her Committee's focus on a single technology and stated that it would be "more scientifically justifiable for the trigger to be on the properties of the organism" as, "if you are introducing a novel crop to this country, there may be something about its novelty that should be regulated to prevent it from becoming weedy or invasive".[442] There is currently no equivalent committee advising the Government on the risks of cultivating conventionally-bred novel crops.

137. **In order to shift both regulatory and public focus from process to trait, the Government must lead by example. It must also take steps to ensure that it is receiving appropriate scientific advice on the risks posed by cultivating conventionally-bred novel plants. *We recommend that the remit of the Advisory Committee on Releases to the Environment be expanded to include cultivation of all novel plants, including those not legally defined as genetically modified organisms. The name of the committee should be amended to reflect this expanded remit.***

Is more information needed?

138. The 2003 *GM Nation* debate showed that participants had "a very strong wish—almost a longing" to be "better informed about GM from sources they could trust".[443] The more recent Public Attitudes to Science survey suggests that, in 2014, most people still "do not feel informed about" genetically modified crops and Sue Davies, *Which?*, confirmed that "a lot of people feel that they need more information" about this technology area, as they are "not really clear as to what the issues are".[444] In light of this, we asked several

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438 Advisory Committee on Releases to the Environment, *Report 2: Towards an evidence-based regulatory system for GMOs*, 27 August 201, p.4. See also Q410 [Professor Hails]

439 ACRE is also responsible for providing advice on non-native species, but this takes up a relatively small amount of its time. The last non-native species to have been assessed by ACRE appears to have been the insect Aphalara itadori, a pest which primarily targets Japanese knotweed, in 2009.

440 Q408 [Professor Hails]

441 Q408 [Professor Hails]

442 Q416

443 Department of Trade and industry, 'GM Nation: the findings of the public debate', September 2003

444 Department for Business, Innovation and Skills/Ipsos Mori, 'Public attitudes to science 2014', Main Report, March 2014, p.6; Q80 [Sue Davies]

witnesses where they would direct someone who wanted to learn more about this technology. We received a broad range of answers. Professor Sir Mark Walport, the Government Chief Scientific Adviser, made repeated reference in his answer to the academic literature and the traditional media,[445] and also mentioned the Science Media Centre and documents produced by scientific organisations such as the Royal Society.[446] He also highlighted the role of the plant science community itself in communicating its work to the public.[447] Sile Lane, Sense about Science, highlighted the work of her own organisation, a charity that "equips people to make sense of science and evidence", and, like Sir Mark, referred to the importance of "local engagement" undertaken by scientists at institutes such as Rothamsted Research.[448] Other witnesses made reference to government websites,[449] the Food Standards Agency (FSA)[450] and other, perhaps less obvious sources of information, such as minutes of FSA meetings and those of other advisory bodies.[451] As Sir Mark acknowledged, there is currently no "single core of public engagement materials on GM" and "sometimes one of the challenges" in obtaining information about this topic "is to recognise the status of different documents".[452]

139. We have come across this challenge—of ensuring that the public has access to the information it needs in order to reach an informed opinion about emerging issues in science and technology—several times during this parliament, and have recommended a variety of different solutions. Most recently, in our 2014 report, *Communicating climate science*, we encouraged the Government to "work with the learned societies and national academies to develop a source of information on climate science" that was "comprehensible to the general public and responsive to both current developments and uncertainties in the science".[453] The Government accepted this recommendation and stated that it was "looking at ways to achieve this".[454] However, witnesses differed in their views about whether a similar resource might be useful with regard to plant biotechnology. Dr Jack Stilgoe, University College London, rejected the idea of "a single one-stop shop" for information about genetic modification, because he did not think the issue could be "defined in a way such that there will be one relevant body".[455] Professor Brian Wynne, University of Lancaster, agreed that there was "no such thing" as a "singular, independent source of scientific knowledge" and argued that "there should not be", because "the nature of scientific knowledge does not allow" for such a value-neutral perspective.[456]

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445 Oral evidence taken on 21 January 2015, HC (2014-15) 958, Qq60-61; Oral evidence taken on 28 January 2015, HC (2014-15) 758, Q332

446 Qq293-295

447 Q295

448 Q57 [Síle Lane]; Q69 [Síle Lane]

449 Q435

450 Q438 [Professor Poppy]

451 Q435 [Professor Gregory]

452 Q295

453 Science and Technology Committee, Eight report of session 2013-14, *Communicating climate science*, HC254, April 2014, para 107

454 Science and Technology Committee, First special report of session 2014-15, *Communicating climate science: Government Response to the Committee's Eighth Report of Session 2013–14*, HC376, June 2014, para 35

455 Q69 [Dr Stilgoe]

456 Q69 [Professor Wynne]

Nevertheless, according to Síle Lane, Sense about Science, while facts are not "the be-all or end-all", "we should not ask people to vote or have an opinion on something when all the information has not been put before them".[457]

140. In its July 2014 report on food security, the Environment, Food and Rural Affairs Committee recommended that the Government "do more to inform the public about the potential beneficial impacts of growing GM crops in the UK" and "encourage an evidence-led public debate" about this subject.[458] The Council for Science and Technology also recently advised the Prime Minister that the Government had a role to play in "explaining [genetic modification], its benefits and how it is regulated".[459] Mr Freeman acknowledged that there was a need to "somehow […] grow public understanding" of this area of technology and that the Government had "a role" in leading that debate.[460] However, Lord de Mauley made no mention of Defra's role in communicating with the public and described his department's "primary" role in relation to genetic modification as that of "regulator".[461]

141. **We highlighted in our previous report *Communicating climate science* that failure by government to engage with the public on controversial topics could create a vacuum in which inaccurate arguments are allowed to flourish without challenge. While the Government has been vocal in its support of genetic modification, it has done little to ensure that the public have access to the resources they need to come to an informed opinion, enabling those with vested interests to dominate the debate and ensure that it remains polarised. No source of information, scientific or otherwise, is ever entirely value-neutral, but the Government must do more to influence the narrative and direct people towards other accurate sources of information. *We recommend that the Government work with the National Academies, in collaboration with Sciencewise, to develop a new online information 'hub' covering emerging topics in science and technology. This should include sections on both climate science and new plant breeding technologies. Each topic area should provide a basic overview of the current evidence base, acknowledging uncertainties where they exist, and should make reference to both scientific and non-scientific considerations. A range of links to other reliable sources of information on all of these aspects should be provided, so that people can tailor their learning to their own priorities and concerns. In the longer term, we envisage this resource becoming a centre for both public information and public debate; the starting point for a more active dialogue about developments in science and technology, especially those related to policy.***

457 Q70 [Síle Lane]

458 Environment, Food and Rural Affairs Committee, Second Report of Session 2013-14 *Food Security*, HC243, 1 July 2014, para 132

459 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015.

460 Q453 [George Freeman MP]

461 Q444 [Lord de Mauley]. See also Q480 [George Freeman MP] Note (in relation to paragraph 141): We highlighted in paragraph 67 that the Government had made clear its support for genetic modification, but had stopped short of explicitly acknowledging that genetically modified crops posed no greater risk than conventionally-bred crops.

Incorporating public views into policy

142. In its 2012 report, *Emerging biotechnologies: technology, choice and the public good*, the Nuffield Council on Bioethics recommended that policy concerning emerging biotechnologies be informed by "public discourse ethics", intended to "give public decision making a properly public orientation by opening up the framing of decisions to the full range of understandings and values that are relevant to them" (see also paragraph 44).[462] Several other witnesses also emphasised the need for public dialogue to inform decision making about science and technology policy. Sir Roland Jackson, a member of the Nuffield Council and Chair of Sciencewise, stated that public and stakeholder engagement had "quite a role to play" in helping to define society's response to emerging technologies and the Science Council stated that "only through increased dialogue […], transparency and openness" would the public "be confident enough to accept the wider use of GM technology".[463] In its recent letter to the Prime Minister, the Council for Science and Technology recognised that the quality of public debate about genetic modification "is substantially enhanced if we acknowledge the different ways in which citizens very properly approach complex issues" and stated that "wider concerns, which go beyond the scientific evidence" needed to be "acknowledged and addressed" in order to "avoid technical issues becoming vehicles for social concerns".[464]

143. The need for value-based considerations to be considered alongside scientific ones has been a strong theme of this report. Professor Andy Stirling, University of Sussex, stated that there was "no stage at which a debate on any technology does not involve values" and that "really is something we should celebrate".[465] However, according to Sir Roland, while the voice of both academia and industry is "strongly" heard across government, "we do not hear so clearly in an integrated way the voice of the rest of civil society" which "tends to have to shout from the sidelines, because it is not involved in Government structures".[466] One of the recommendations of the 1999 Nuffield Council on Bioethics report on genetically modified crops was the establishment of an "independent biotechnology advisory committee to consider scientific and ethical issues together with public values associated with GM crops".[467] According to Sir Roland, a member of the Council, this "effectively became the Agriculture and Environment Biotechnology Commission", which "had broader oversight of this area and brought societal values and perspectives into the discussion".[468] This body was abolished in 2004 following controversy over its advice and the extent to which it differed from government policy at the time.[469] No replacement body has since been established and attempts at public deliberation in this area have had mixed success (see paragraphs 112-114). Equivalent bodies do, however, exist elsewhere in the

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462 Nuffield Council on Bioethics, *Emerging biotechnologies: technology, choice and the public good*, December 2012, para 10.6

463 Q227 [Sir Roland Jackson]; GMC047 [Science Council] para 4.8

464 Council for Science and Technology, *Letter to the Prime Minister: GM technologies*, 21 November 2013, accessed 26 January 2015.

465 Q257 [Professor Stirling]

466 Q236 [Sir Roland Jackson]

467 GMC035 [Nuffield Council on Bioethics]

468 Q219

469 'Minister to abolish GM scrutiny body", The Guardian, 29 December 2004, accessed 27 January 2015

policy-making landscape. Several years ago, the Biotechnology and Biological Sciences Research Council (BBSRC) set up a permanent 'Bioscience for Society Strategy Panel', which is responsible for providing "strategic input on the social dimensions of the conduct and outcomes of research supported by BBSRC".[470] It has considered and provided advice on topics including predictive health,[471] food security[472] and bioenergy.[473] The Medical Research Council has an 'Ethics, Regulation and Public Involvement' committee, responsible for providing advice on policy related to research involving human participants and other issues involving the public, and also provides support to the Nuffield Council on Bioethics, an independent body that examines and reports on ethical issues in biology and medicine.[474] Medical policy is also informed by the National Institute for Health and Care Excellence's (NICE) 'citizens council', a demographically diverse panel of 30 members of the public, responsible for providing NICE with "a public perspective on overarching moral and ethical issues that NICE has to take account of when producing guidance".[475] However, other areas of science and technology are less well covered and there is currently no equivalent body responsible for providing guidance to policy-makers on either agricultural issues, or other policy-relevant topics related to science and technology.

144. **When making decisions about emerging issues in science and technology, we consider it important that a broad range of social and ethical factors be taken into consideration. These should be considered alongside scientific advice and evidence, but should remain distinct from it.** ***We recommend that ACRE should, in its recommended expanded role, establish a permanent 'Citizens Council' based on the model developed by the National Institute for Health and Care Excellence. This new Council should be responsible for considering and providing advice on the potential social and ethical impacts of developments within ACRE's remit. Sciencewise could ensure best practice in the framing and facilitation of debate as well as coordinating the work of all such citizen councils.***

The role of Sciencewise

145. Sciencewise is a Government-funded "national centre for public dialogue" which aims to "to support policy makers to commission and use excellent public dialogue as an integral part of policy making".[476] Its creation stemmed from the House of Lords Science and Technology Committee's 2000 report, *Science and Society*, which highlighted the importance of public input into challenging areas of new and emerging science and called

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470 Biotechnology and Biological Sciences Research Council, 'Bioscience for Social Strategy Panel', accessed 27 January 2015

471 Bioscience for Social Strategy Panel, *Minutes of the Bioscience for Society Strategy Advisory Panel meeting held on 20 May 2014*, accessed 27 January 2015

472 Bioscience for Social Strategy Panel, *Minutes of the Bioscience for Society Strategy Advisory Panel meeting held on 20 May 2014*, accessed 27 January 2015

473 Bioscience for Social Strategy Panel, *Minutes of the Bioscience for Society Strategy Advisory Panel meeting held on 18 January 2012*, accessed 27 January 2015

474 Medical Research Council, 'Ethics, Regulation & Public Involvement Committee', accessed 27 January 2015

475 National Institute for Health and Care Excellence, 'Get involved: Citizen's Council', accessed 27 January 2015

476 Sciencewise, 'About us: aims and objectives', accessed 27 January 2015

for more meaningful engagement between scientists, policy makers and the public.[477] Following an initial round of funding for specific projects in the mid-2000s, the Council for Science and Technology's recommended that the Government "create a mechanism" through which learnings from future dialogue projects could be captured and shared, and which would help generate "a change in culture where dialogue is seen as a normal part of government's policy development processes on science and technology related issues".[478] Sciencewise was subsequently established as a permanent "expert resource centre for public dialogue in science and innovation" in 2007.[479]

146. According to an internal review of Sciencewise's work between 2010 and 2012:

> Evidence shows that public dialogue projects completed with Sciencewise support: influenced policy decisions and plans […]; improved policy and decision-making […]; helped policy makers gain new perspectives and insights from the public participants […]; and influenced policy and decision making systems to include more public dialogue in future. In addition, dialogue results were often widely disseminated to policy and decision makers. Unexpected outcomes included reduced conflict between stakeholders, and new local initiatives being established.[480]

A further independent evaluation of Sciencewise's work from 2012 onwards is currently underway and is expected to "feed into decisions" by the Government "about the future of the programme".[481] Sciencewise is funded by the Department for Business, Innovation and Skills and we understand that its annual budget is approximately £2.7 million.[482]

147. When asked about the role of Sciencewise, the Government Chief Scientific Adviser, Professor Sir Mark Walport, stated that "public funding of science engagement is important and, therefore, the programme that Sciencewise does is important".[483] He agreed with the "broad principle" that Government should be funding such work but declined to comment on whether or not Sciencewise's funding should be maintained.[484] George Freeman MP, Minister for Life Sciences, stated that Sciencewise played a part in "promoting and building a public dialogue, a public discourse, a public understanding, and the feeding in of public views across policy making" and emphasised the importance of this activity.[485] However, when asked about the organisation's future, Mr Freeman did not comment on whether or not Sciencewise's funding would be renewed.[486]

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477 Sciencewise, 'About us: background', accessed 27 January 2015

478 Council for Science and Technology, *Policy through dialogue: informing policies based on science and technology*, March 2005, para 9

479 Sciencewise, 'About us: background', accessed 27 January 2015

480 Sciencewise, *Sciencewise - Interim Evaluation 2012*, March 2013, p.1

481 Sciencewise, 'Learning resources: Evaluation: Sciencewise programme evaluation', sciencewise-erc.org.uk, accessed 27 January 2015

482 Personal correspondence

483 Oral evidence taken on 28 January 2015, HC (2014-15) 758, Q335

484 Oral evidence taken on 28 January 2015, HC (2014-15) 758, Qq336-337

485 Q483

486 Q483

148. **Public discourse should play a key role in informing policy concerning society's use of science and technology and Sciencewise is central to ensuring that this is ingrained in the policy-making process.** ***We recommend that the Government renew its support for Sciencewise and commit to stable or uplifted funding over the next five years.***

The role of Government

149. The Government was clear about the need to widen the frame of debate about genetic crop technologies. George Freeman MP, Minister for Life Sciences, stated that there was a need to:

> move this debate on from where it has slightly been locked in the public discourse, as GMOs and genetically modified food, to a much broader discussion about how we embrace the extraordinary benefits of genetics across health, and, more broadly, animal health, plant health, agricultural sustainability, productivity, the ecosystem and habitat development.[487]

Mr Freeman also emphasised the need to "open up public understanding of the range of different technologies and applications" available to plant breeders, and "point out that traditional breeding—Mendelian, sort of caveman seed choice—is a very slow and clumsy form of genetic manipulation of seed stock".[488]

150. During our inquiry, we learned that the Government Office for Science, in collaboration with *Which?* and Sciencewise, had recently started work on a dialogue project intended to help policy-makers understand "the different challenges facing the food system".[489] According to the project's webpage, its objectives are:

- to explore public and consumer awareness and perspectives of current food system problems, challenges and opportunities; and
- to explore public and consumer attitudes to potential solutions (including; types of food production methods, new technologies or other solutions in the context of demand-side approaches and waste reduction) that could be used to address the challenges of food supply and sustainable intensification.[490]

Sue Davies, Chief Policy Adviser at *Which?*, explained that this project would "take specific case studies of foods and explore the social issues and challenges in terms of food security, sustainability, health, food prices" and so on.[491] She emphasised that "GM" was "not the starting point" for this project; rather, "it is about technologies and different solutions in general".[492] According to Ms Davies, the project involves "an external advisory group and input from different Government Departments to make it as relevant to policy as

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487 Q465

488 Q453 [George Freeman MP]

489 Q81 [Sue Davies]

490 Sciencewise, 'Dialogue projects: UK food system challenges and the role of innovative production technologies and other approaches in meeting these', accessed 27 January 2015

491 Q81 [Sue Davies]

492 Q82

possible".[493] We understand that the project is likely to consist of six events in three different locations and that it is supported by a grant from Sciencewise of approximately £42,000.[494] Sir Mark indicated that it was likely to publish its outputs at some point in 2015.[495]

151. **The Government Office for Science's planned dialogue project on the UK food system is a positive step and, we hope, will enable the Government to think more broadly about the public's priorities and concerns in relation to food production. However, in our view this small-scale project does not go far enough. What is needed is a far broader, more substantive and inclusive public conversation.** ***We recommend that the Government use the current project as a springboard to a more substantial public dialogue on the future of the UK food system. This should be on a similar scale to the 2003 'GM Nation' debate, but should draw upon the lessons learned from that exercise and should utilise the information hub recommended in paragraph 138 as an additional centre of dialogue. The information gained from this process should inform the direction of future policy in these areas. We ask that the Government set out in its response to this report a high level plan for this exercise, together with a proposed timeframe and initial budget.***

493 Q83

494 Personal correspondence

495 Qq297-300

Conclusions and recommendations

Terminology and the framing of the debate

1. The term genetic modification, or GM, is most commonly used to describe a transgenic process in which a gene from one organism is inserted, often at random, into the genome of another organism of a different species. This fails to accurately portray the wide range of techniques through which targeted genetic changes can now be introduced into crops, which include same species cisgenic transfers, precise point changes to the plant genome and epigenetic modifications that do not alter the underlying genetic sequence. In our view, it is time to update this imprecise and problematic terminology. (Paragraph 18)

2. We recognise that the term GM has become embedded in everyday language and is now often used imprecisely to encompass a whole range of technologies. In this report—except when quoting from evidence or using legally significant terminology—we will attempt to avoid using the term 'GM' and will use the phrase 'genetic modification' only when referring specifically to the first generation transgenic techniques to which it has historically been applied. We will avoid this terminology when referring more broadly to the full range of advanced genetic techniques currently in development. We recommend that the Government initiate a reframing of the public conversation by similarly moving away from the overly simple notion of 'GM' in its own policies and communications. (Paragraph 19)

3. We do respect that people have every right to such views but restate our earlier observation that those views on ethical or moral grounds should not imply or claim that those objections have any basis in scientific evidence. (Paragraph 27)

4. We received no evidence to suggest that genetic modification, or any other single technology, was widely viewed as a potential cure-all for global agricultural problems. It is clear that a diversity of approaches—technological, social, economic and political—will be required to meet the challenge of delivering sustainable and secure global food production. However, advanced genetic approaches do have a role to play. We are convinced by the evidence provided to us that this suite of technologies is a potentially important tool, particularly in the developing world, which should not be rejected unless there is solid scientific evidence those technologies may cause harm. (Paragraph 30)

5. By constantly framing genetic modification alongside other novel, controversial or potentially harmful technologies (for example, nanotechnology, animal cloning and pesticides), the Government encourages the public to understand genetic modification in the same terms. By failing to widen its framing beyond the narrow concept of 'GM', the Government also perpetuates old debates and preserves the perceived distinction between genetically modified and conventionally bred plants. Finally, by publicly insisting that decisions about this technology be made on the basis of scientific advice alone, the Government shuts down opportunities for wider debate and encourages those who are simply opposed to the technology to continue to contest the science. We recommend that both the Government and the Food

Standards Agency review their public communications on genetic modification and related topics to ensure that these are framed in a way that encourages constructive public debate. Advice on this process should be sought from the Sciencewise expert resource centre and identified changes should be made by the end of 2015. (Paragraph 135)

Devolution of decision making

6. The hard won amendment to the Deliberate Release Directive is intended to ease problems with the operation of the regulatory system by ceding more power to Member states. However, it does nothing to resolve underlying weaknesses in the regulations or to prevent those hostile to GMOs from voting against authorisation in order to maintain the current EU-wide 'ban' on GMO cultivation. It may also do little to attract the agricultural biotechnology industry back to Europe. We commend those Governments that have provided leadership in attempting to secure more fundamental legislative change but share their view that the agreed amendment is far from satisfactory. (Paragraph 90)

7. In our view, decisions about access to and use of safe products should be made by national governments on behalf of the populations that elected them, not by the EU. The most significant flaw in the current EU regulatory system for GMOs is its continued failure to enable Member states to make such decisions without prejudice. We remind those in the EU who are opposed to GMO cultivation that the purpose of shared regulation should be to ensure mutual protection from unsafe products, not to unjustifiably restrict the choices available to other elected governments and the citizens whom they represent. We encourage all member states to vote in favour of authorising those products that have been deemed safe by the European Food Safety Authority so that national governments can make their own decisions about how best to act in their electorate's interests. (Paragraph 91)

8. We also encourage the new President of the European Commission, Mr Jean-Claude Juncker, and the new Health and Consumers Commissioner, Mr Vytenis Andriukaitis, to bear this point in mind in their planned review of the procedural rules governing GMO authorisation. (Paragraph 92)

9. This Committee does not scrutinise the policies of the Devolved Administrations but we hope that they note the observations of this report and understand that foods, most especially animal feeds, increasingly contain elements of genetically modified crops despite their inclination not to permit the growth of such crops. (Paragraph 24)

10. While recognising that agricultural policy is a devolved area and respecting the right of the Devolved Administrations to maintain a restrictive approach to the use of advanced genetic crop breeding techniques, we reject the Scottish Government's suggestion that this policy has a scientific basis. We encourage all of the Devolved Administrations to take an evidence-based approach to policy on the use of advanced genetic approaches to crop improvement. Where policies are based on other considerations, this should be made clear: allegations of scientific uncertainty should not be used as a pretence for value-based objections. (Paragraph 25)

Publicly funded research and development

11. We do not consider an annual Biotechnology and Biological Sciences Research Council investment of £4 million—from a total budget of nearly £500 million and a plant science budget of £70 million—to represent an excessive investment in advanced genetic approaches to crop improvement. We are also content that the Government's approach to agricultural research is balanced and does not focus excessively on genetic techniques. We therefore reject the claim that preferential investment in this field has prevented research from progressing in other areas of agricultural research. (Paragraph 37)

12. Claims of funding bias are difficult to refute on the basis of the information on government research spend that is currently published. We recommend that the Government's annual Science, Engineering and Technology statistics be enhanced to provide greater aggregate detail on the areas of research in which public funds have been invested. We also recommend that each UK Research Council includes an aggregated breakdown—for example, at the level of each strategic 'theme'—in its annual report and provides additional information on past funding decisions in areas where there are common misconceptions, such as plant science. (Paragraph 39)

13. We have not been convinced by the argument that the application of intellectual property rights to genetically advanced crops has hindered other innovation trajectories and we have seen little evidence to support claims that patents pose a significant barrier to independent research. However, it is clear that this subject raises strong emotions and we agree with the Royal Society that this is a complex matter that warrants further consideration. We recommend that the Government conduct a review of the intellectual property landscape, specifically in relation to agricultural technologies, and its potential impact on the commercialisation of both conventionally bred and genetically improved crops. We would expect this to be delivered to our successor Committee by the end of 2015. (Paragraph 43)

14. We recognise that the debate about innovation in agriculture is often too narrowly framed around the single subject of 'GM' and we agree that this has likely led to an unnecessary polarisation of views. However, we see no compelling evidence that this has 'locked out' alternative innovation options: if anything, it may have had the effect of prejudicing the public against advanced genetic approaches. (Paragraph 45)

15. It is clear from the evidence we have received that fears that the pursuit of advanced genetic approaches to crop improvement inevitably 'locks out' alternative technologies and solutions are ill-founded. Nevertheless, we recognise the need for society to remain open to a variety of innovation trajectories and for policy-makers to look beyond the single dimension of economic growth when considering the potential costs and benefits of any emerging technology. (Paragraph 47)

16. In this respect, we endorse many of the recommendations of the Nuffield Council's recent report on this subject and reiterate our previous conclusion that the Government Office for Science is not best located in the Department for Business, Innovation and Skills, where its frame of evaluation risks being invariably dominated by economic considerations. In its response to this report, the Government should set out how the Nuffield Council's work on emerging biotechnologies has informed

its research policy. We are particularly interested in how it has responded, or intends to respond, to the Council's call for structural reorganisation. (Paragraph 48)

EU regulation and agricultural innovation

17. It is clear to us that an interpretation of the precautionary principle has significantly influenced the EU's approach to GMO regulation and we consider the claim, made by a representative of the European Commission, that the principle has never been implemented for GMO authorisation to be, at best, disingenuous. If the precautionary principle is to avoid being used as a political tool, greater clarity is needed regarding when, and how, it has been used. In order to avoid future ambiguity, we recommend that the Commission clearly and publicly state when it has drawn on the precautionary principle in the policy formation process. (Paragraph 53)

18. A regulatory system under which it takes many years—sometimes decades—to reach a decision cannot possibly be considered fit for purpose. Evidence clearly shows that the current EU regulatory regime for GMOs is not working, and has not worked for some time. We await signs of whether the recent changes will significantly change the outcome for companies seeking approval to grow GM crops in Europe. (Paragraph 59)

19. The current EU legislative framework for novel plants is founded on the premise that genetically modified plants pose inherently greater risk than their conventional counterparts. The weight of peer-reviewed scientific evidence, collected over many years, has shown this to be unjustified. Where genetically modified crops have been shown to pose a risk, this has invariably been a result of the trait displayed—for example, herbicide tolerance—rather than the technology itself. We are disappointed that the Government has not more publicly argued this fact. We recommend that the Government publicly acknowledge that genetically modified crops pose no greater inherent risk than their conventional counterparts. A statement recognising this fact should be included in the Government's response to this report and relevant areas of GOV.UK should be updated to reflect this. (Paragraph 68)

20. The EU's process-based regulatory system for novel crops is increasingly proving itself to be incapable of dealing with advances in technology. This raises the prospect that potentially important agricultural innovations will be hindered, or even halted, by inappropriate regulation, while potentially harmful crops may escape appropriate control if they are produced using techniques not captured by GMO regulations. (Paragraph 70)

21. We consider the current process-based EU legislative framework for GMOs to be fundamentally flawed and unfit for purpose. (Paragraph 71)

22. We acknowledge that there is a need to "tread carefully" with regard to trait-based regulation and recognise that a change in UK policy on this issue is unlikely to pay immediate dividends. However, we consider it likely that a move to trait-based regulation at EU-level will eventually be forced by technological progress and suggest that the Government would be wise to prepare for such a change. We recommend that the Government formally adopt a move to trait-based novel plant regulation as a

long-term policy goal and begin to develop its preferred framework for such a system so that this can inform EU discussions. The Government should provide our successor committee with an update on this work by the end of 2015. (Paragraph 73)

23. In the meantime, we urge the European Commission to take a pragmatic and evidence-based approach to its development of policy regarding emerging techniques for genetic crop improvement. We remind it that such techniques are likely to be vital to ensuring future global food security and that inappropriate regulation may have significant negative consequences for both the UK and the EU as a whole. (Paragraph 74)

24. In attempting to centralise decision-making about risk management, the current EU regulatory system limits the ability of member states to take local political factors into account. The result is undue politicisation of the risk assessment process. Those opposed to genetic modification seek to exaggerate scientific uncertainty in order to block or delay authorisation. This, in turn, leads to stalemate at the voting stage, where strongly conflicting political positions inevitably prevent agreement from being reached. To resolve this, decision-making about risk management, including the decision whether or not to cultivate an authorised GMO, must be repatriated to member states. We consider the current EU regime to be at variance with the principle of subsidiarity. We remind the Council, the Commission and the Parliament of their responsibility to observe this principle. (Paragraph 85)

25. We understand the challenge of securing major legislative change in the EU—particularly in relation to this subject—and therefore the Government's inclination towards delivering small improvements to the current regime rather than attempting a more significant overhaul. However, fundamental flaws in the design of this legislative framework have created a regulatory process that is not fit for purpose, has driven research activity out of the EU and which is putting the UK's agricultural future at risk. Substantial regulatory reform is no longer merely an option, it is a necessity. We recommend that the Government publicly state its long-term commitment to major reform of the EU legislative framework for genetically modified organisms and other novel crops. (Paragraph 94)

26. We urge the European Commission to consider the conclusions and recommendations set out in this report and provide our successor committee with a formal response, by the end of 2015, to those issues for which it has responsibility. (Paragraph 95)

Taking account of risk

27. Good risk management requires the potential benefits of an action to be thoroughly considered alongside the risks. It also requires a consideration of the risk of failing to act. Current GMO legislation fails to adequately recognise this point and the European Commission, as risk manager, has proved itself incapable of taking (or unwilling to take) these factors into account on a discretionary basis. This has led to a one-sided decision-making process and has sent a misleading message to the public about the potential value of these products, to the economy, society and the environment. We urge the Commission to give greater recognition to the full array of potential social, economic and environmental benefits offered by GMOs and the

potential consequences of failing to adopt these products during EU risk assessment and risk management processes. (Paragraph 77)

28. Science and politics each have a role to play in both risk assessment and risk management. However, while risk management is rightly a politically-led process, risk assessment must be led by science if it is to effectively contribute to evidence-based policy-making. This distinction has not been sufficiently observed in the EU's regulation of GMOs. (Paragraph 84)

29. We agree with the European Commission that a precautionary approach is appropriate in circumstances where scientific evidence is insufficient, inconclusive or uncertain and when there is reason to believe that potentially dangerous effects on the environment, human, animal or plant health might result if precaution is not exercised. However, it is clear from the evidence that we have received that these conditions are not met simply because a crop has been produced via genetic modification. Continued recourse to the precautionary principle in relation to all genetically modified crops is therefore no longer appropriate. Indeed, it has acted as a barrier to progress in this field. (Paragraph 100)

30. There are vast discrepancies between the European Commission's stated approach to applying the precautionary principle and its adoption in practice. Uncertainty about how the principle is being used at EU level is not helped by the lack of a consistent definition. We recommend that the European Commission consult with stakeholders in order to update its 2000 'Communication' on the precautionary principle. The updated document should include a clear definition of the principle and should stipulate the necessary conditions for it to be used as a basis for EU policy. In future, when the European Commission draws upon the precautionary principle in its policy making, it should publicly state: a) how the controlled activity meets its specified conditions for recourse to the precautionary principle; b) how measures adopted in response align with the general principles of risk management (described above), and c) what is being done to resolve uncertainties and render continued precautionary measures unnecessary. (Paragraph 102)

31. We remind the Commission that any legislation guided by the precautionary principle must allow for an exit from precautionary measures once there is strong scientific consensus that any risks are low. (Paragraph 103)

32. We have already acknowledged the considerable relevance of societal concerns to decision-making about risk and reiterate the need for non-scientific factors to be considered alongside scientific risk assessment during the risk governance process. However, the precautionary principle was designed primarily as a response to scientific uncertainty, not value-based ambiguity. Such ambiguities are common in emerging areas of science and technology and are also often intractable; recourse to the precautionary principle in these scenarios would therefore potentially act as a permanent barrier to the use of safe innovations. Where value-based ambiguities exist, public discourse, not scientific risk assessment, should be pursued as a route to greater legitimacy. (Paragraph 109)

33. We recommend that the Government give greater consideration to the value that participatory processes might contribute to its own treatment of risk and uncertainty in policy development. We particularly refer the Government to the Risk Governance Framework and Safe Foods Initiative and ask it to set out how the perspectives offered by these documents will inform its future approach to risk governance policy. (Paragraph 110)

34. The Government recognises the importance of properly understanding and applying the precautionary principle, but it is not clear that it has done so. Government explanations emphasise the need for decisions made under the guidance of the precautionary principle to be based on a "full science-based evaluation", but fail to recognise that such evaluations are often impossible in those circumstances when precaution is most needed—that is, in situations of scientific uncertainty or ignorance. The Government Chief Scientific Adviser's first annual themed report, on the subject of innovation and risk, has done little to clarify this situation. The Government should prepare a short document, informed by wider consultation, detailing its understanding of the principle and the circumstances in which it intends to use the precautionary principle as a guide to policy making. This should be made publicly available by the end of 2015. (Paragraph 113)

Public understanding and debate

35. The term 'GM' has become a lightning rod for much broader public anxiety, in particular regarding our environmental future and the level of control wielded by large multinationals. These are legitimate concerns, but are currently centred on an inappropriate target. Whether a GM product is 'good' or 'bad', either for the environment or for society more broadly, should focus more clearly on how it is used than the technology utilised to produce it. This fact is lost in the continuing focus on 'GM'. There is a need to reframe and widen the public debate to encourage a more productive conversation about what we, as a society, want from our food supply and what sort of agriculture we would like that supply to be based upon. (Paragraph 121)

36. Evidence suggests that members of the public currently find it difficult to develop an informed opinion about whether or not they support technologies such as genetic modification. This needs to change if there is to be meaningful public debate and if future policy is to be usefully informed by the insights that such debate can bring. (Paragraph 124)

37. We have performed no detailed study of BBC coverage for this inquiry; however, we again emphasise the central role that the BBC plays in communicating science and remind it of its responsibility, as a public sector broadcaster, to promote learning and encourage conversation and debate about this important topic. We encourage all of the media, particularly public broadcasters, to conduct a review of their own content on genetic modification, 'GM' and other related topics to ensure that it is fulfilling these public duties. In particular, consideration should be given to how this topic is framed and whether it is being considered broadly enough in the context of other agricultural methods and wider issues of food production and food security. (Paragraph 127)

38. We are each entitled to our own opinion and value-based opposition to genetic modification, or any other technology, is perfectly legitimate. However, this does not justify knowingly and willingly misinforming the public. We strongly urge those seeking to inform the public about genetic modification and other advanced genetic plant technologies to provide an honest picture of the scientific evidence base and the regulatory controls to which these products are currently subject. Where opposition to such technologies is value-based, this should be openly acknowledged and should not be concealed behind false claims of scientific uncertainty and misleading statements regarding safety. (Paragraph 129)

39. We question the basis for Greenpeace's opposition to golden rice—a crop that is undergoing rigorous safety evaluations and has the potential to help protect many hundreds of thousands of children in the developing world from preventable blindness and early death—and question its public claim that this crop is "environmentally irresponsible" and "poses risks to human health". We recognise that biofortification cannot replace a balanced diet but remind those who oppose golden rice that the best should not be the enemy of the good. We urge those organisations that actively campaign against the take-up of golden rice in other regions of the world to carefully consider how this position impacts on their professed humanitarian aims. We recommend that all such organisations—and specifically Greenpeace—review their public communication materials to ensure that they are evidence-based and honest in setting out the reasons for opposition to this technology. (Paragraph 132)

40. We highlighted in our previous report Communicating climate science that failure by government to engage with the public on controversial topics could create a vacuum in which inaccurate arguments are allowed to flourish without challenge. While the Government has been vocal in its support of genetic modification, it has done little to ensure that the public have access to the resources they need to come to an informed opinion, enabling those with vested interests to dominate the debate and ensure that it remains polarised. No source of information, scientific or otherwise, is ever entirely value-neutral, but the Government must do more to influence the narrative and direct people towards other accurate sources of information. We recommend that the Government work with the National Academies, in collaboration with Sciencewise, to develop a new online information 'hub' covering emerging topics in science and technology. This should include sections on both climate science and new plant breeding technologies. Each topic area should provide a basic overview of the current evidence base, acknowledging uncertainties where they exist, and should make reference to both scientific and non-scientific considerations. A range of links to other reliable sources of information on all of these aspects should be provided, so that people can tailor their learning to their own priorities and concerns. In the longer term, we envisage this resource becoming a centre for both public information and public debate; the starting point for a more active dialogue about developments in science and technology, especially those related to policy. (Paragraph 141)

41. Public discourse should play a key role in informing policy concerning society's use of science and technology and Sciencewise is central to ensuring that this is ingrained

in the policy-making process. We recommend that the Government renew its support for Sciencewise and commit to stable or uplifted funding over the next five years. (Paragraph 148)

42. The Government Office for Science's planned dialogue project on the UK food system is a positive step and, we hope, will enable the Government to think more broadly about the public's priorities and concerns in relation to food production. However, in our view this small-scale project does not go far enough. What is needed is a far broader, more substantive and inclusive public conversation. We recommend that the Government use the current project as a springboard to a more substantial public dialogue on the future of the UK food system. This should be on a similar scale to the 2003 'GM Nation' debate, but should draw upon the lessons learned from that exercise and should utilise the information hub recommended in paragraph 138 as an additional centre of dialogue. The information gained from this process should inform the direction of future policy in these areas. We ask that the Government set out in its response to this report a high level plan for this exercise, together with a proposed timeframe and initial budget. (Paragraph 151)

The Advisory Committee on Releases to the Environment

43. In order to shift both regulatory and public focus from process to trait, the Government must lead by example. It must also take steps to ensure that it is receiving appropriate scientific advice on the risks posed by cultivating conventionally-bred novel plants. We recommend that the remit of the Advisory Committee on Releases to the Environment be expanded to include cultivation of all novel plants, including those not legally defined as genetically modified organisms. The name of the committee should be amended to reflect this expanded remit. (Paragraph 137)

44. When making decisions about emerging issues in science and technology, we consider it important that a broad range of social and ethical factors be taken into consideration. These should be considered alongside scientific advice and evidence, but should remain distinct from it. We recommend that ACRE should, in its recommended expanded role, establish a permanent 'Citizens Council' based on the model developed by the National Institute for Health and Care Excellence. This new Council should be responsible for considering and providing advice on the potential social and ethical impacts of developments within ACRE's remit. Sciencewise could ensure best practice in the framing and facilitation of debate as well as coordinating the work of all such citizen councils. (Paragraph 144)

Formal Minutes

Wednesday 11 February 2015

Members present:

Andrew Miller, in the Chair

Jim Dowd	Pamela Nash
David Heath	Sarah Newton
Stephen Metcalfe	Graham Stringer
Stephen Mosley	David Tredinnick

Draft Report (*Advanced genetic techniques for crop improvement: regulation, risk and precaution*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 151 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Fifth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 25 February at 9.00 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the Committee's inquiry page at www.parliament.uk/science.

	Question number
Wednesday 15 October 2014	
Professor Ottoline Leyser, Fellow, The Royal Society, **Professor Sir David Baulcombe**, Regius Professor of Botany, University of Cambridge, **Dr Doug Parr**, Chief Scientist and Policy Director, Greenpeace UK, and **Liz O'Neill**, Director, GM Freeze	Q1-56
Wednesday 29 October 2014	
Síle Lane, Director of Campaigns, Sense About Science, **Dr Jack Stilgoe**, Lecturer in Social Studies of Science, University College London, and **Professor Brian Wynne**, Professor of Science Studies, Lancaster University	Q57-78
Sue Davies, Chief Policy Adviser, Which?, and **Jon Woolven**, Strategy and Innovation Director, Institute of Grocery Distribution	Q79-105
Dr Helen Ferrier, Chief Science and Regulatory Affairs Adviser, National Farmers Union, **Peter Melchett**, Policy Director, Soil Association, and **Professor Ian Crute**, Non-executive Director, Agriculture and Horticulture Development Board	Q106-140
Wednesday 5 November 2014	
Professor Helen Sang, Fellow, Society of Biology, **Professor Michael Bevan**, Programme Leader, Cell and Developmental Biology, John Innes Centre, and **Dr Paul Burrows**, Executive Director, Corporate Policy and Strategy, Biotechnology and Biological Sciences Research Council	Q141-177
Dr Mike Bushell, Principal Scientific Advisor, Syngenta, **Dr Julian Little**, Chair, Agricultural Biotechnology Council, and **Dr Geoff Mackey**, Sustainable Development and Communications Director, BASF Europe North	Q178-214
Wednesday 19 November 2014	
Professor Paul Nightingale, Deputy Director, Science Policy Research Unit, University of Sussex, **Professor Andy Stirling**, Co-director, STEPS Centre, University of Sussex, **Professor Joyce Tait**, Director, Innogen Institute, University of Edinburgh, and **Sir Roland Jackson**, Member, Nuffield Council on Bioethics	Q215-262
Professor Sir Mark Walport, Chief Scientific Adviser to HM Government and Head of the Government Office for Science	Q263-303

Monday 1 December 2014

Dr Elisabeth Waigmann, Head of Genetically Modified Organisms Unit, European Food Safety Authority, and **Professor Joe Perry**, Chair, Genetically Modified, Organisms Panel, European Food Safety Authority	Q304-349
Eric Poudelet, Director, Safety of the Food Chain, Directorate General for Health, and Consumers, European Commission, and **Dorothée André**, Head of Unit, Biotechnology, Directorate General for Health and Consumers, European Commission	Q350-405

Wednesday 7 January 2015

Professor Rosemary Hails, Chair, Advisory Committee on Releases to the Environment, **Professor Peter Gregory**, Chair, Advisory Committee on Novel Foods and Processes, and **Professor Guy Poppy**, Chief Scientific Adviser, Food Standards Agency	Q406-442
Lord de Mauley, Parliamentary Under-Secretary of State for Natural Environment and Science, Department for Environment, Food and Rural Affairs, and **George Freeman MP**, Parliamentary Under-Secretary of State for Life Sciences, Department for Health and the Department for Business, Innovation and Skills	Q443-486

Published written evidence

The following written evidence was received and can be viewed on the Committee's inquiry web page at www.parliament.uk/science. INQ numbers are generated by the evidence processing system and so may not be complete.

1	Geoffrey H Sherrington	GMC0001
2	Steve Yandall	GMC0002
3	Jean-Yves Tillier	GMC0003
4	Steps Centre	GMC0004
5	The Family Farmers' Association	GMC0005
6	Mrs Pippa Woods	GMC0006
7	Alan Malcolm	GMC0008
8	The James Hutton Institute	GMC0009
9	Mark Lynas	GMC0010
10	Mark Cantley	GMC0011
11	John Innes Centre	GMC0012
12	Professor Christopher John Pollock	GMC0013
13	Soil Association	GMC0014
14	Sense About Science	GMC0015
15	Professor Joe N Perry	GMC0016
16	Dr Rupert Read	GMC0017
17	Dr Richard Mark Weightman	GMC0018
18	BASF plc	GMC0019
19	GM Freeze	GMC0020
20	Tessa Burrington	GMC0021
21	National Farmers' Union	GMC0022
22	Dr Calestous Juma	GMC0023
23	Kevin R Coleman	GMC0024
24	Royal Society of Chemistry	GMC0025
25	Professor Sir David Baulcombe	GMC0027
26	GARNet	GMC0028
27	SCIMAC	GMC0029
28	Advisory Committee on Releases to the Environment	GMC0030
29	Agricultural Biotechnology Council	GMC0031
30	Alliance for Natural Health International	GMC0032
31	Charmian Larke	GMC0033
32	Bayer CropScience Ltd	GMC0034
33	Nuffield Council on Bioethics	GMC0035
34	Syngenta	GMC0036
35	Agriculture and Horticulture Development Board	GMC0037
36	Dr J David Reece	GMC0039
37	Dr Charles Clutterbuck	GMC0040
38	Wildlife and Countryside Link	GMC0041
39	Greenpeace	GMC0042

40	Which?	GMC0043
41	The Royal Society	GMC0044
42	Professor Paul Nightingale	GMC0045
43	Society of Biology	GMC0046
44	Science Council	GMC0047
45	Food Standards Agency	GMC0048
46	Paul Wheelhouse MSP, Minister for Environment and Climate Change, The Scottish Government	GMC0049
47	Department for Environment, Food and Rural Affairs (Defra) and the Department for Business, Innovation and Skills (BIS)	GMC0051
48	Innogen Institute, University of Edinburgh	GMC0052
49	Dr Charles Clutterbuck (supplementary to GMC0040)	GMC0053
50	Professor Joe N Perry	GMC0054
51	Institute of Grocery Distribution	GMC0055
52	Greenpeace UK (supplementary to GMC0042)	GMC0056
53	GM Freeze (supplementary to GMC0020)	GMC0057
54	John Innes Centre (supplementary to GMC0012)	GMC0058
55	Agricultural Biotechnology Council (supplementary to GMC0031)	GMC0059
56	Welsh Government	GMC0060
57	Department of the Environment, Northern Ireland	GMC0061
58	The Scottish Government	GMC0062
59	Society of Biology (supplementary to GMC0046)	GMC0063

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the Committee's website at www.parliament.uk/science.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2014–15

First Special Report	Communicating climate science: Government Response to the Committee's Eighth Report of Session 2013–14	HC 376
First Report	Ensuring access to working antimicrobials	HC 509 (Cm 8919)
Second Special Report	Government horizon scanning: Government Response to the Committee's Ninth Report of Session 2013–14	HC 592
Second Report	After the storm? UK blood safety and the risk of variant Creutzfeldt-Jakob Disease	HC 327 (Cm 8940)
Third Special Report	Ensuring access to working antimicrobials: Research Councils UK Response to the Committee's First Report of Session 2014–15	HC 643
Third Report	National Health Screening	HC 244 (Cm 8999)
Fourth Report	Responsible Use of Data	HC 245

Session 2013–14

First Special Report	Educating tomorrow's engineers: the impact of Government reforms on 14–19 education: Government Response to the Committee's Seventh Report of Session 2012–13	HC 102
First Report	Water quality: priority substances	HC 272–I (HC 648)
Second Special Report	Marine science: Government Response to the Committee's Ninth Report of Session 2012–13	HC 443
Third Special Report	Bridging the valley of death: improving the commercialisation of research: Government response to the Committee's Eighth Report of Session 2012–13	HC 559
Second Report	Forensic science	HC 610 (Cm 8750)
Fourth Special Report	Water quality: priority substances: Government response to the Committee's First Report of Session 2013–14	HC 648
Third Report	Clinical trials	HC 104 (Cm 8743)
Fifth Special Report	Clinical trials: Health Research Authority Response to the Committee's Third Report of Session 2013–14	HC 753
Fourth Report	Work of the European and UK Space Agencies	HC 253 (HC 1112)
Fifth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Natural Environment Research Council (NERC)	HC 702
Sixth Special Report	Forensic science: Research Councils UK Response to	HC 843

	the Committee's Second Report of Session 2013–14	
Seventh Special Report	Clinical trials: Medical Research Council Response to the Committee's Third Report of Session 2013–14	HC 874
Sixth Report	Women in scientific careers	HC 701 (HC 1268)
Seventh Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Arts and Humanities Research Council (AHRC)	HC 989
Eighth Special Report	Work of the European and UK Space Agencies: Government Response to the Committee's Fourth Report of Session 2013–14	HC 1112
Eighth Report	Communicating climate science	HC 254 (HC 376, Session 2014–15)
Ninth Report	Government horizon scanning	HC 703 (HC 592, Session 2014–15)
Ninth Special Report	Women in scientific careers: Government Response to the Committee's Sixth Report of Session 2013–14	HC 1268

Session 2012–13

First Special Report	Science in the Met Office: Government Response to the Committee's Thirteenth Report of Session 2010–12	HC 162
First Report	Devil's bargain? Energy risks and the public	HC 428 (HC 677)
Second Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Medical Research Council	HC 510–I
Second Special Report	Engineering in government: follow-up to the 2009 report on Engineering: turning ideas into reality: Government Response to the Committee's Fifteenth Report of Session 2010–12	HC 511
Third Report	The Census and social science	HC 322 (HC 1053)
Fourth Report	Building scientific capacity for development	HC 377 (HC 907)
Fifth Report	Regulation of medical implants in the EU and UK	HC 163 (Cm 8496)
Sixth Report	Proposed merger of British Antarctic Survey and National Oceanography Centre	HC 699 (HC 906)
Third Special Report	Devil's bargain? Energy risks and the public: Government Response to the Committee's First Report of Session 2012–13	HC 677
Fourth Special Report	Building scientific capacity for development: Government and UK Collaborative on Development Sciences Response to the Committee's Fourth Report of Session 2012–13	HC 907
Fifth Special Report	Proposed merger of British Antarctic Survey and National Oceanography Centre: Natural Environment Research Council Response to the Committee's Sixth Report of Session 2012–13	HC 906
Seventh Report	Educating tomorrow's engineers: the impact of Government reforms on 14–19 education	HC 665 (HC 102, Session 2013–14)
Eighth Report	Bridging the valley of death: improving the commercialisation of research	HC 348 (HC 559, Session 2013–14)

Sixth Special Report	The Census and social science: Government and Economic and Social Research Council (ESRC) Responses to the Committee's Third Report of Session 2012–13	HC 1053
Ninth Report	Marine science	HC 727

Session 2010–12

First Special Report	The Legacy Report: Government Response to the Committee's Ninth Report of Session 2009–10	HC 370
First Report	The Reviews into the University of East Anglia's Climatic Research Unit's E-mails	HC 444 (HC 496)
Second Report	Technology and Innovation Centres	HC 618 (HC 1041)
Third Report	Scientific advice and evidence in emergencies	HC 498 (HC 1042 and HC 1139)
Second Special Report	The Reviews into the University of East Anglia's Climatic Research Unit's E-mails: Government Response to the Committee's First Report of Session 2010–12	HC 496
Fourth Report	Astronomy and Particle Physics	HC 806 (HC 1425)
Fifth Report	Strategically important metals	HC 726 (HC 1479)
Third Special Report	Technology and Innovation Centres: Government Response to the Committee's Second Report of Session 2010–12	HC 1041
Fourth Special Report	Scientific advice and evidence in emergencies: Government Response to the Committee's Third Report of Session 2010–12	HC 1042
Sixth Report	UK Centre for Medical Research and Innovation (UKCMRI)	HC 727 (HC 1475)
Fifth Special Report	Bioengineering: Government Response to the Committee's Seventh Report of 2009–10	HC 1138
Sixth Special Report	Scientific advice and evidence in emergencies: Supplementary Government Response to the Committee's Third Report of Session 2010–12	HC 1139
Seventh Report	The Forensic Science Service	HC 855 (Cm 8215)
Seventh Special Report	Astronomy and Particle Physics: Government and Science and Technology Facilities Council Response to the Committee's Fourth Report of Session 2010–12	HC 1425
Eighth Report	Peer review in scientific publications	HC 856 (HC 1535)
Eighth Special Report	UK Centre for Medical Research and Innovation (UKCMRI): Government Response to the Committee's Sixth Report of session 2010–12	HC 1475
Ninth Report	Practical experiments in school science lessons and science field trips	HC 1060–I (HC 1655)
Ninth Special Report	Strategically important metals: Government Response to the Committee's Fifth Report of Session 2010–12	HC 1479
Tenth Special Report	Peer review in scientific publications: Government and Research Councils UK Responses to the Committee's Eighth Report of Session 2010–12	HC 1535
Tenth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Technology	HC 1539–I

	Strategy Board	
Eleventh Special Report	Practical experiments in school science lessons and science field trips: Government and Ofqual Responses to the Committee's Ninth Report of Session 2010–12	HC 1655
Eleventh Report	Alcohol guidelines	HC 1536 (Cm 8329)
Twelfth Report	Malware and cyber crime	HC 1537 (Cm 8328)
Thirteenth Report	Science in the Met Office	HC 1538
Fourteenth Report	Pre-appointment hearing with the Government's preferred candidate for Chair of the Engineering and Physical Sciences Research Council	HC 1871–I
Fifteenth Report	Engineering in government: follow-up to the 2009 report on Engineering: turning ideas into reality	HC 1667 (HC 511, Session 2012–13)