

THE OPPORTUNITIES FROM GM AND BIOTECHNOLOGY FOR SCOTLAND

Summary

- *The unexpected announcement last month by Scottish Government of a ban on commercial growing of EU approved GM crops in Scotland provoked a concerned response from many in the scientific, business and farming communities.*
- *This reaction was because the announcement:*
 - *was made in emotive language likely to fuel negative public perceptions about GM and related technologies.*
 - *assumes a degree of public hostility to GM that is not supported by recent public attitude surveys. The latest evidence is that public acceptability of GM foods is increasing*
 - *was not taken on the basis of scientific advice*
 - *assumes the ban would enhance sales of Scottish produce by projecting a “clean and green” image whereas the evidence for this is far from certain. Indeed, competition from GM products grown elsewhere may be detrimental to the competitiveness of Scottish agriculture*
 - *does nothing to enhance Scotland’s longstanding reputation for scientific creativity. Instead it could damage its ability to attract and retain innovative researchers and disadvantage the growth of important Scottish businesses*
- *GM is one of a range of innovative biotechnologies which could be of economic benefit to Scotland. It is important therefore that there is an evidence-based public debate about GM across civic Scotland. This Advice Paper is published to help stimulate a rational and respectful debate on a complex issue where there are deeply held opposing views.*
- *The debate should recognise the international context of a Scottish ban and in particular that:*
 - *GM crops are being widely developed internationally based on increasing knowledge of plant biology and genetics and using new very precise techniques*
 - *some imminent developments of GM crops and many second generation developments will serve the needs of important Scottish markets and will have much clearer environmental and societal benefits than those currently in use*
- *much of Scotland’s food and drink industry is dependent on external supply of raw materials, which may not be GM-free, or may not be produced under ‘clean and green’ conditions*
- *the EU system of regulation and approval of GM is particularly stringent. European science advisory bodies such as the European Academies Science Advisory Council EASAC are concerned it needs to be improved as it mitigates against the development and cultivation of new GM crops with environmental and societal benefits within Europe.*
- *As a contribution to inform such a debate, the Scottish Government should publish all advice and evidence that led it to reach its decision to ban GM crop cultivation, while continuing to support and allow research into GM and related technologies.*

Introduction

- 1 The Royal Society of Edinburgh (RSE) notes the recent announcement by the Scottish Governmentⁱ that it would seek to use new EU measuresⁱⁱ to prevent the growing of current EU-approved genetically modified (GM) crops in Scotland and the subsequent debate that has taken place between groups and individuals on the issues raised.
- 2 The RSE recognises that the issue of GM is one that stimulates a range of views. We recognise the democratic right of governments to take decisions on policy issues and opposition to GM crops has been a longstanding position of the current Scottish Government. We are firmly of the view, however, that such decisions are best taken after comprehensive consideration of the relevant and available evidence. In the case of GM, and biotechnology more widely, this should include due consideration of the scientific research evidence, the regulatory regime, an accurate understanding of the state of public opinion, the impact on research and education, the economic consequences, and how a decision impacts on Scotland’s agriculture, food and drink sectors.

- 3** In the light of the Scottish Government announcement, the RSE set up a broadly-based group reflecting the considerable expertise within the Fellowship of the RSE and the membership of the RSE Young Academy of Scotland. Uniquely within the UK, the expertise of the RSE’s Fellowship spans all academic disciplines, as well as business and public administration; many of our Fellows have significant experience of working with, and within, the Research Councils and the wider research system. The RSE Young Academy of Scotland is similarly multi-disciplinary and its members include many of the top young researchers and emerging leaders active in Scotland today, from the worlds of science, social science and humanities, the professions, the arts, business and civil society.
- 4** This Advice Paper examines, both from a natural and social science perspective, the Scottish Government’s intention to ban the cultivation of GM crops in the context of the current landscape as it applies to biotechnology in relation to agriculture, as well as an exploration of other fields of biotechnology. It also considers the potential that biotechnology has to provide economic or societal benefits to Scotland and internationally.
- 5** This response has been approved by the General Secretary of the RSE on behalf of Council.
- 8** It is important to recognise that, due to the stringent regulatory regime applied by the EU before approval is given to any GM crop, the amended EU legislation does not permit the use of scientific evidence as the basis for decisions to reject the growing of GM crops. The Scottish Government’s decision, based on political and policy considerations, has therefore been taken on an administrative procedural basis and without setting out the evidence basis for such a decision. It is disappointing that the Scottish Government has gone down this route, given its strong support for science and innovation as the bedrock of the Scottish economy and as a key basis for policy making. We are pleased that the Cabinet Secretary added that the contained use of GM plants would continue to be permitted for scientific research purposes, which has also been repeated in a letter from the First Minister to Murdo Fraser MSP (10 September).
- 9** The RSE was one of 28 learned societies and research institutions that signed an open letter to the Cabinet Secretary seeking a meeting with him to discuss the basis for his decision. A meeting between the Cabinet Secretary and several of the representatives of signatories to the letter took place on the 9th September. Other learned societies have written separately to the Cabinet Secretary.
- 10** In the interests of promoting an informed debate on the role of GM and other biotechnologies in the future in Scotland, the RSE decided, as a first step, to prepare this Advice Paper in order to set out the various factors that should be taken into account by the Scottish Government, the scientific community, the agricultural sector and society. In preparing this Paper, the RSE recognises that significant reports have been produced in the UK recently should be taken into account. In particular we seek to draw attention to the report on GM Science Update^{iv} prepared for the Council for Science and Technology (CST) in March 2014 and a report on Synthetic Biology^v prepared by the Scottish Science Advisory Council (SSAC) in September 2014.

Background

- 6** GM crops are being developed around the world based on our increased knowledge of the biology and genetics of crop plants and the ways in which we can improve important characteristics such as yield, nutritional qualities and resistance to pests, diseases, salinity or drought. New molecular techniques allow precision in creating specific GM products.
- 7** In August, the Cabinet Secretary for Rural Affairs, Food and the Environment rather unexpectedly announced that the Scottish Government would use new EU legislation, which allows member states and, in the UK, devolved administrations, to prevent the growing of EU-approved GM crops in Scotland. This amended Directive allows such action to be taken on a case-by-case basis, provided it is “reasoned, proportional and non-discriminatory and, in addition, based on compelling grounds...”ⁱⁱⁱ The statement was welcomed by some NGOs, but drew widespread criticism from many in the scientific, business and farming communities who were concerned that it had not been made with full consideration being given to all of the scientific evidence.

The opportunities offered by biotechnologies

- 11** Globally, we face the challenge of feeding an expanding population, while with increased prosperity in many countries food consumption will grow. Other challenges include climate change, reductions in areas of productive land and competing demands for natural resources such as fresh water. The decision on GM crops cannot be isolated within the realm of agriculture. The 21st Century has been called “The century of biology” and like most developed nations Scotland is looking to the bio-economy to deliver a significant portion of its future prosperity in a manner that is more environmentally sustainable than in the past.

Case Study: Potato

Potato is the 3rd largest food crop in the world. Potato blight is the number one disease. Currently, farmers control blight losses by spraying pesticides (up to 20 times annually) – the current global costs associated with blight losses and control measures exceed \$10 billion annually (as presented by Barbara Wells, Director General of the International Potato Centre, Beijing July 2015).

The James Hutton Institute in Dundee is involved in world-leading research into potato blight and the research into a solution that uses GM tools to combine natural sources of resistance is reaching the point where the technology is possible and is beginning to be taken up by others, including in the US and East Africa. The US company Simplot estimates that this provides the potential for a 25 – 45% reduction in pesticide applications^{vi} .

Plant viruses and the aphid insects that transmit them cause serious economic losses, limit crop production, and have negative effects on the quality and security of food supplies. Infection by viruses is a major cause of degeneration of potato seed stocks. Economic losses caused by only two of the major potato viruses (PVY and PVA) in the UK alone are estimated at £18 million annually (<http://fera.co.uk/plantClinic/potatoInform/documents/informSept11.pdf>).

Field-based resistance to major potato viruses produced using GM technology has been available for some time (Kaniewski et al. 2004)^{vii} , and allows reduction in the use of insecticides to control the insects transmitting the viruses.

*Modern GM tools raise two types of challenge for Scottish agriculture in light of this decision: (i) **Ware potatoes.** The adoption of new blight-resistant potato lines would enable Scottish farmers to be ‘cleaner and greener’ by greatly reducing their use of fungicides. If they are not able to take up this opportunity, they will become uncompetitive with farmers from other countries who are able to produce potatoes with an improved environmental footprint at a cheaper price; (ii) **Seed potatoes.** Modern GM techniques can also be used to derive potatoes resistant to viruses^{viii}, potentially undermining Scotland’s seed potato industry which is worth about £100 million per year. These potatoes will also lead to a global potato industry that is environmentally more sustainable through reduced use of insecticides.*

- 12 Industrial biotechnology, in which the Scottish Government and large and small companies have already made a significant investment, will be increasingly reliant on advanced biotechnologies to support the development of conventional chemical feedstocks without the use of fossil fuels. Industrial biotechnology will also be important in advanced manufacturing processes for tomorrow’s drugs and other complex molecules.
- 13 The SSAC report on Synthetic Biology sets out a range of areas in which synthetic biology provides opportunities for Scotland in research and industrial areas, including: utilising industrial biotechnology in the production of fine and speciality chemicals; the rational design of new active therapeutics for the treatment or prevention of a wide variety of diseases; the generation of fuels from biological materials; and a range of potential agricultural applications.
- 14 The SSAC, in its key findings, also noted that Scotland has strength and depth in the technologies of synthetic biology and called for a dialogue between scientists, the public, industry and the Scottish Government, noting that, because of its wide expertise in the natural and social sciences, Scotland is well placed to lead on such discussions internationally.
- 15 The implications for the biological science community in general in Scotland also need to be considered. Scotland historically has benefitted from a reputation as an enlightened place to progress scientific research and many world-class scientists have been attracted or retained here as a result. This is recognised in the continued success of Scottish universities and research institutions in attracting competitive Research Council grants above the *per capita* average across the UK. Scotland can build on this existing strength and potentially benefit from spin-out businesses if we embrace fully the range of biotechnologies that are now emerging and which can provide benefits to the economy as well as solutions to some of the major international challenges. Conversely, if we do not embrace these technologies, then the benefits will accrue elsewhere in the UK and the world, leading scientists will move along with the technologies and Scotland will either be left behind or end up importing technology as a late adopter.

- 16** In considering the diverse range of existing and emerging biotechnologies, we must strive for equivalence and parity in their evaluation for adoption, while still scrutinising specific applications on a case-by-case basis. For example, if vaccines containing GMOs or their products are considered safe to release into the environment in large-scale vaccination programmes, is it logical that GM plants should be banned from release, even in controlled trials? It is a hallmark of good legislation and regulation that it must be evidently fair and consistent, otherwise it is open to public challenge. Scotland's reputation for supporting and gaining benefit from specific biotechnologies in the medical arena will be damaged if that pioneering spirit and logic is not followed through in a consistent approach to other areas of innovative biotechnology.
- 20** Maintaining crop production to underpin Scotland's food and drink industry will become increasingly challenging due to upcoming legislation banning certain crop protection chemicals. Similarly, it is difficult to predict the full effects of future climate change on Scotland's crops, but more extreme weather events will certainly make it increasingly difficult to produce the consistent quality of product needed by the whisky and other industries. GM technology offers crucial benefits in the speed, accuracy and specificity with which crop growth traits can be improved (relative to the speed of conventional breeding, and assuming the adoption of a less lengthy and onerous regulatory approval process – see below). In order to gain the potential future benefits of GM, Scotland needs to be building an expertise now in its introduction and in the trialling of specific traits of value to the Scottish farming and food and drink sectors.

The economic and environmental argument

- 17** The Scottish Government decision was based on “potential wider economic considerations” and the perception that Scottish produce was “internationally valued” for having been produced under “clean, green and natural conditions”.
- 18** The value of the food and drink sector of £14 billion to the Scottish economy has been highlighted as supporting this argument. However, to date no substantive economic or market analysis has been produced as backing for the decision against GM cultivation. If such analyses are available their publication would be helpful in informing the current public debate.
- 19** As counter-arguments and as illustrations of some of the difficulties this policy may impose on the Scottish economy, the following should be considered:
- much of the imported feed for cattle is based on GM soya and maize from North and South America, yet there seems to be no negative consumer reaction to the consumption of Scottish or UK beef;
 - the whisky industry already needs to import some of its barley and other grains from other countries, including the USA. While there is no commercial cultivation of GM barley yet in the EU, there have been field trials. If, in the future, GM barley is widely cultivated, the whisky industry may decide to import this or face difficulties sourcing non-GM barley;
 - in support for the farmed salmon industry, omega-3 oils will be available sourced from GM crops or algae. This will provide a more sustainable alternative to the current use of wild fish for salmon feed.
- 21** The issue of “clean, green and natural” quoted by the Scottish Government does not recognise two key issues: that much of Scottish agriculture has been developed to sustain production for export (e.g. alcohol) that does not contribute to food security for the population; and in order to sustain agriculture in Scotland, we have become reliant on imports such as nitrogen fertiliser, phosphate and high-protein animal feed from South America – sensitive to geopolitical shifts and far from clean and green.
- 22** Both conventional and organic agriculture use a range of fertilisers and pesticides to maximise yields and some of these are detrimental to the environment. Many GM crop species under active research and development are aimed at reducing agricultural inputs of fertiliser or pesticides or reducing soil damage. These developments can provide significant environmental benefit^x. A meta-analysis of the impacts of GM crops by Klumper & Qaim shows a reduction in pesticide quantity use of 37% and an increased yield of over 21% – also leading to increased farm profits on the adoption of GM crops^x. The SRUC also produced a report in 2013 on the farm level economic impacts of GM, which showed increased profitability; although the effect on profits was lower in the most developed countries.^{xi}
- 23** Where the scientific evidence suggests that there are environmental risks for a particular crop that outweigh any benefits, then that advice is given. For example GM herbicide tolerant oil-seed rape was considered unsuitable for Scotland and much of northern Europe – not specifically because of the GM aspect, but due to the combined use of the crop with the herbicides.

24 Contrary to there being a negative economic impact of embracing a range of biotechnologies, Scotland may be able to generate new SMEs around the areas of expertise that exist in our universities and research institutes, as well as encouraging partnerships with larger enterprises. The clusters of businesses that develop around our major research intensive universities provide evidence for this in other fields of science.

Regulatory framework

25 Underpinning any cultivation of GM crops in Europe is the regulatory regime that applies. The CST report notes that the commercial release of GM crops is subject to more stringent regulation than conventionally bred plants. It further goes on to note “that the current EU regulations add €10 – 20 millions to the cost of developing a new GM variety – an amount that is prohibitive for small and medium sized enterprises and the public sector.”^{xii}

26 The CST report further notes that the “European Academies Science Advisory Council (EASAC) and others have pointed out that there is no rational basis for the current stringent EU regulatory process. There are no reliable data indicating inherent risk for human or animal health, for the environment or from unforeseen effects.”

27 The current regulatory framework is not seen as conducive to enabling and encouraging small and medium-sized companies that may wish to apply for approval to market GM crops and derived products. Indeed, the associated costs and negative perceptions of the EU approval process has resulted in even large companies developing their new crops elsewhere in the world and withdrawing specific applications for cultivation in the EU marketplace. Raising barriers to entry for small and medium-sized companies is likely in the long run to lead to more monopolies and oligopolies – quite the reverse of what many who are concerned about the domination of a few large companies wish to see.^{xiii}

28 Another area of innovation where the EU regulatory regime has unintended consequences is in smart diagnostics. One such example is a bio-sensor to detect arsenic in drinking water that was developed in Scotland, but is being moved to the USA for manufacture as it is classed in the EU as deliberate release of a product of GM. A similar fate may well apply to new animal and poultry vaccines being developed using GM and related technologies.

Public attitudes to biotechnology

29 In reference to “the will of the people”, citizens’ views on GM have adapted and modified considerably over the years. Opinion poll and survey evidence suggests that attitudes to GM crops and food are less negative than they have been in the past. In a recent Ipsos Mori poll (2014) on Public Attitudes to Science, more people in the UK said that the benefits of GM crops are greater than the risks, by 36% to 28%.^{xiv}

30 When asked about the statement whether “Genetically modified crops are needed to increase world food production,” 57% agreed against 15% who disagreed. When asked a more general proposition that “We should not rule out any agricultural techniques or technologies that might help to increase world food production”, 80% agreed against 9% who disagreed.

31 It is important to consider the public and societal benefits of adopting biotechnologies and of communicating these potential benefits. This should be part of a broader public debate on the role of scientific research in tackling global challenges and the response in the Ipsos Mori poll to the question on “increasing world food production” highlights the significance of this.

32 A survey commissioned by the British Science Association as part of National Science and Engineering Week (British Science Association 9 March 2012) demonstrated similar levels of decline in opposition to, as well as support for, GM foods in general, with large numbers of citizens having moved into the neutral ground. Where there were significant public benefits, for example, the production of rice crops with enhanced levels of vitamin A, there was strong support – over 64% supported the use of such a crop, with only 13% opposed. (Enhanced levels of vitamin A can help protect against blindness, thought to affect over 100 million children globally). Similarly, producing wheat crops with reduced susceptibility to aphids, thereby reducing the use of pesticides, was also supported by 58%, with only 15% against.

33 It would be unfortunate if the Scottish Government were to have taken this important decision with so many potential implications for the future of the Scottish economy on the basis of inaccurate information about the feelings and preferences of the Scottish public. The available evidence suggests that public opinion on GM crops and technologies is more nuanced now than it has been in recent years and, given more balanced, evidence-based information about new developments and their benefits, could become significantly more positive.

- 34** As evidence for the potential to have a more nuanced dialogue about such issues than has been possible in the past, some important NGOs (e.g. WWF and RSPB) are no longer campaigning actively against GM crops. Also, some influential past members of environmental activist groups have publicly rejected their previous stance on GM crops. Kenya, Uganda, Burkina Faso, Nigeria, Ghana and South Africa have all approved the growing of GM crops. The current position in Scotland runs the risk of being out of step with international developments. It is important for governments to lead and stay ahead of public attitudes and not lag behind them. We note that some other EU countries may also pursue a similar line to that of the Scottish Government.
- 35** At the time of the 2012 British Science Association survey, there was a call by some MPs for a “grown up debate about GM”. The time may now be right for such a debate to take place across civic Scotland.

The role of scientific advice in Government

- 36** The RSE is strongly of the view that expert scientific advice should be available to Government Ministers and civil servants when considering policy issues related to science. We have expressed this view in the past in a briefing note to the Scottish Parliament. From the ambiguous Government responses to the question of whether the Chief Scientific Adviser (Rural Affairs, Food and the Environment) had been involved in the decision to ban the growing of GM crops, it would appear that she was not, despite her evident expertise in this area. It is also unfortunate that the Scottish Government’s announcement was made at a time when the post of Chief Scientific Adviser (CSA) had been vacant since the start of the year and there are many vacancies on the Scottish Science Advisory Council. This regrettable coincidence could create a perception of an “anti-science attitude”. We are therefore pleased that the First Minister confirmed that a new recruitment process for a CSA would begin towards the end of the year.
- 37** In relation to the issues around GM, and innovative biotechnologies in general, there is a key role for the CSA to play in encouraging an evidence-based debate that enables the public to reach reasoned conclusions on the use and perceived safety of these technologies and their role in tackling many key societal challenges.

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- ii Directive (EU) 2015/412, March 2015.
http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ:JOL_2015_068_R_0001
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- iv GM Science Update, Council for Science and Technology, March 2014. Baulcombe et al.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/292174/cst-14-634a-gm-science-update.pdf
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<http://scottishscience.org.uk/article/opportunities-scotland-synthetic-biology-ssac-report-published>
- vi <http://www.simplotplantsciences.com/index.php/press-releases/view/usda-deregulates-innate-second-generation-potatoes>
- vii Kaniewski, W., Lawson, C., Sammons, B., Haley, L., Hart, J., Delannay, X., Turner, N. 9 (1990) Field resistance of transgenic Russet Burbank Potato to effects of infection by potato virus X and potato virus Y. *Biotechnology*, 8(8), 750-754 Kaniewski, W.K. & Thomas, P.E. (2004). The potato story. *AgBioForum*, 7 (1&2), 41-46.
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- xii p32 Baulcombe et al.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/292174/cst-14-634a-gm-science-update.pdf
- xiii Tait, J., (2014) Bringing it all Together. In *Annual Report of the Government Chief Scientific Adviser, 2014. Innovation: Managing Risk not Avoiding It*. Evidence and Case Studies, pp 129-136
<https://www.gov.uk/government/publications/innovation-managing-risk-not-avoiding-it>
- xiv Public Attitudes to Science 2014. <https://www.ipsos-mori.com/Assets/Docs/Polls/pas-2014-main-report.pdf>
- xv RSE Briefing paper to the Scottish Parliament, December 2012.
https://www.royalsoced.org.uk/cms/files/advice-papers/2012/BP12_02.pdf

Additional Information

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