

The regulation of genome-edited plants in the European Union

EASAC commentary on the statement by the German National Academy of Sciences Leopoldina, the Union of the German Academies of Sciences and Humanities, and the German Research Foundation

Introduction to new plant breeding techniques

Agriculture continues to face major challenges to deliver food and nutrition security at a time of increasing pressures from social and economic inequity and instability, population growth, climate change and the need to avoid further loss in ecosystem biodiversity. The production of more food, more sustainably, requires the development of crops that can make better use of limited resources and will contribute significantly to attaining multiple Sustainable Development Goals.

In this commentary, the European Academies' Science Advisory Council (EASAC) expresses full support for the recent statement by the German National Academy of Sciences Leopoldina, the Union of the German Academies of Sciences and Humanities together with the German Research Foundation (Leopoldina *et al.* 2019) entitled 'Towards a scientifically justified, differentiated regulation of genome edited plants in the EU', which was prepared in response to the European Court of Justice (ECJ) decision of 2018 (C-528/16). We also note the significance of the recent decision by the European Council (Council of the European Union, 2019) to ask the European Commission to clarify the status of novel genomic techniques with regard to the options to update the existing legislation.

New breeding techniques are emerging rapidly from advances in genomics research, for application in crop improvement. They enable targeted changes in the genome and they have significant potential for the sustainable intensification of agriculture, when used as part of the deployment of all available approaches to achieving food and nutrition security and building on existing good agronomic practice. Unlike chemical- or radiation-induced mutagenesis, often traditionally used for crop improvement tools, the new breeding techniques do not create multiple, unknown, unintended mutations throughout the genome. Furthermore, the products of the new breeding techniques are also unlike genetically modified organisms (GMOs) used in agriculture, in being more precisely targeted and having no foreign DNA in the end product. Advances in plant genome editing may also support other applications for the Bioeconomy in support of European competitiveness (see later).

The scientific opportunities coming into range in plant breeding, for example, to develop more climate-resilient agriculture, resistant to the increasing abiotic

and biotic stresses, have been examined previously by EASAC (for example EASAC 2017a, 2017b) and have been explored extensively in the scientific literature (for example, the recent comprehensive review by Bailey-Serres *et al.* (2019)).

ECJ decision and the German statement recommendations

In 2018, the ECJ decided that organisms obtained by the new techniques of genome editing are GMOs within the meaning of the Directive 2001/18/EC on the release of GMOs into the environment, and they are subject to the obligations in the legal framework laid down by the GMO Directive. This ECJ declaration has been controversial (see, for example, Holme *et al.* 2019) and the background to this judgement with implications for EU science, innovation and regulation have been discussed in detail in the scientific and policy communities, for example the Group of Chief Scientific Advisers to the European Commission (2018). Their GCSA Opinion observed that new scientific knowledge has made the GMO Directive no longer fit for purpose, that the current approach does not properly respect the motivation behind the precautionary principle

for ensuring product safety, and that the regulatory framework should put the emphasis on the features of the end product rather than on the production technique.

The recent German institutions' statement provides detailed assessment of the history of molecular breeding methods in agriculture, of the current research and innovation regulatory approaches used worldwide, with particular regard, for example, to issues for safety assessment and for intellectual property protection. The German statement also examines the consequences, particularly for world trade, arising from lack of consistency in regulatory approaches and the problems for product verifiability. In response to the ECJ decision, Leopoldina *et al.* (2019) propose a range of coordinated recommendations to reform EU genetic engineering law that would take account of science-based criteria in the approval process. These reforms require concomitant action to strengthen science and competitiveness in the EU (Box 1).

These recent recommendations that include concrete textual suggestions for the amendment of EU genetic engineering law are consistent with messages emerging

Box 1 Summary of recommendations from Leopoldina *et al.* (2019)

The first step is to amend EU genetic engineering legislation to include revising the GMO definition, or the associated exemptions, in order to exempt genome-edited organisms from the scope of the legislation if (1) no foreign genetic information is inserted and/or (2) if there is a combination of genetic material that could also result naturally or through traditional breeding methods.

Beyond the short-term amendment of current genetic engineering legislation, a second step should comprise developing a fundamentally new legal framework that is detached from the previous process-based regulatory approach. The new, science-based, legal framework must link the requirements of authorisation and registration to the resulting traits.

To ensure continuing development of the science base and responsible innovation in agriculture, it is also important for the European Commission and Member States to do the following.

Make field trials of new crop varieties practicable again as quickly as possible.

Support public engagement about new breeding methods, to take account of, and inform, consumer views.

Enable freedom of choice by consumers, using consistent labelling rules.

Provide broader support for responsible innovation in agriculture, e.g. by public funding of research on the health, environmental, economic, ethical and societal consequences of products and application scenarios of new molecular breeding methods. Support for innovation must also ensure that the precautionary principle is not linked to speculative risks but rather applied in the context of potential benefit-risk considerations and the risk of doing nothing.

Increase market competition by targeted incentives with particular regard to small and medium-sized enterprises currently deterred by high bureaucratic and cost obstacles.

Source: Leopoldina *et al.* (2019) with summarising by EASAC of original text on recommendations.

from EASAC work during the past two decades (EASAC 2004, 2011, 2013, 2015, 2017a, 2017b, 2018) and, indeed, with other international policy development initiatives. In addition to the international examples that the German statement cites for different regulatory approaches outside the EU (and the likelihood of increasing divergence) can be added the example of Australia and New Zealand. There, very recent recommendations from the Food Standards Authority (2019) include a proposal to revise and modernise definitions in the Code for food produced using gene technology, to ensure that new breeding techniques are regulated in a manner commensurate with the risk that they pose.

The development of strategic options for the EU has to reflect the increased knowledge derived from an ever-faster pace of science together with the accumulating experience worldwide on the use of modern molecular methods to understand plant biology. Significant opportunities are described in the German statement, including genome-edited crops already marketable elsewhere with benefits for nutrition and productive, low-pesticide and resource-conserving agriculture. In addition, there is collective need to do more to understand the genetic diversity existing naturally within a species. Although the core genome is shared by all varieties within a species, individual varieties will differ in other genes such that there may well be more, and more significant, differences between two conventional varieties than between a conventional variety and its edited counterpart.

In this brief commentary, EASAC endorses the recommendations summarised in [Box 1](#) and takes this opportunity to update and reiterate some of our previous messages.

Global implications

It is crucially important to take account of the changing world as well as scientific advances when reflecting on policy options. EU reforms in the regulation of plant breeding are urgently needed if the objectives for EU innovation are to be met, including those for the Common Agricultural Policy, the Green Deal, and the Bioeconomy. It must also be appreciated that EU policy decisions have very significant implications elsewhere in the world. In the past, for example, the EU over-regulation of GMOs had negative impact on science and innovation in developing countries who feared for their export markets and who had been inclined to look to the EU to express leadership in research and development. This EU deterrent to innovation in developing countries can be perceived as undermining EU development policies aiming to build international collaboration in science and technology. These problems for food and nutrition security and sustainability in the rest of the world created by EU

decisions are compounded by the EU exporting its lack of agricultural sustainability (EASAC, 2013, 2017b), partly in consequence of not employing on its territory all available technologies for sustainable intensification.

Given the escalating, shared, problems associated for example, with climate change, it is vital that EU actions take account of our responsibilities in the global context and that we do not repeat our past mistakes in failing to capitalise on advances in the biosciences.

Addressing policy disconnects

In addition to the disconnect noted above between EU development policy objectives for science and technology collaboration, and the consequences of over-regulated and inconsistent GMO policy, EASAC has previously emphasised (EASAC 2013, 2018) other contradictions which undermine the EU desire for coherent strategy to address major societal challenges. These contradictions include those between:

- The European Commission's leadership in support for science *and* those regulatory impediments to innovation that are felt most strongly in academia and the small and medium-sized enterprises. EU citizens are poorly served if their contribution to the funding for cutting edge science does not lead to them benefitting from the knowledge generated.
- The productivity goals for EU climate-resilient agriculture (for planetary health) that also protects human health *and* the practical difficulties in using all appropriate technologies to respond to climate change.
- The environmental goals for EU agriculture to reduce the external application of chemicals (fertilisers, pesticides and herbicides) *and* the impediments to identifying and breeding new crop varieties that require less application of such chemicals. The United Nations Year of International Plant Health in 2020 is particularly relevant for reaffirming the contribution that improved plant breeding can make to plant and planetary health. The EU could provide leadership globally to reduce the use of pesticides and fertilisers as well as mitigating the impact of environmental change on food sustainability.
- The current EU practice of importing genetically modified food and feed that is not approved for cultivation on EU land: the consequences of this also run counter to EU aspirations to limit 'food miles'. Unless the EU response to climate change includes developing climate-resilient agriculture, it can be foreseen that the EU will require to import more food and feed, and an increasing proportion

of this is likely to be from the use of new breeding techniques elsewhere in the world.

Ethical issues and proportionality

EASAC has previously highlighted (EASAC, 2017a) how there is a moral obligation to fight disease and relieve suffering. To the extent that genome editing technologies provide useful tools to achieve such purposes, there is an opportunity cost in using them too late or not at all, particularly if they are safer, more effective and cheaper than alternative technologies.

Ethical problems are raised by conflicting values, by interests that pull in different directions. If and when interests or values clash (when certain values or interests can only be achieved at the expense of others), principles are available that can guide the decision-making. Two such principles with implications for the particular issue of plant breeding are the precautionary principle and the principle of proportionality.

If the precautionary principle implies 'do nothing if there are unknown risks', this will halt progress, and doing nothing also entails risks (EASAC, 2015). But if the principle means only 'act with caution', it has to be made clear what this means in practice. Safety is obviously important, but so are the benefits. One possibility is to say that it suggests: 'act according to the principle of proportionality'. The precautionary principle, if strictly interpreted, requires work to stop if there are uncertainties about the risks involved, and it places the burden of proof of safety on those who want to promote a change. But the principle of proportionality is more open, in its four conditions (Hermeren, 2012), which at all times can be discussed, assessed, argued for and applied in the light of the present evidence. Decisions can then be taken, which can be changed as the scientific evidence and value landscape changes:

1. *Importance of objective* — the intended goal, theoretical or practical, should be important.
2. *Relevance of means* — the means should bring about or at least help to achieve the goal.
3. *Most favourable option* — there is no other less controversial or risky means to achieve the goal(s).
4. *Non-excessiveness* — the means used should not be excessive in relation to the intended goal, which requires analysis, argument and interpretation.

This suggests an approach, termed stewardship, implying or encouraging an ongoing overview of processes in the light of changing evidence and values within restrictions imposed for example by respect for human rights. However, experience of GMO Panel

members of the European Food Safety Authority (Casacuberta and Puigdomenech, 2018) indicates that there has been a reduction in the flexibility of the risk assessment procedures for GMO crop applications, even while the evidence base worldwide (including the substantial evidence for lack of harm) has accumulated. From this perspective, there is pressing need to make use of the proportionality principle when introducing reform to strengthen the use of scientific evidence and tackle future uncertainties.

The issues are receiving considerable attention in Member States and the European Commission. For example, the Opinion published in France by the Ethics Committee of INRA (2016) provided an important perspective on the link between agricultural and environmental considerations. The European Group on Ethics in Science and New Technology recently organised a roundtable on gene editing, including plant applications (EGE, 2019) and discussion was clearly polarised. It continues to be important to take the range of public perceptions into account, against a background of contested knowledge, when formulating policy in this area (see next section) and the forthcoming Opinion to be published by the EGE will be a significant contribution to catalysing further discussion.

Public opinion

Public discussion about GMO crops tended to become a proxy for other much-needed discussion about food security and safety, farming systems, fair competition, social justice, the economic power of multi-national companies and the apparent conflict between intellectual property protection and benefit sharing (EASAC, 2013). If the differing public values are to be better understood as part of attempts to reconcile them and if we wish to avoid repeating the same mistakes in public engagement on genome editing, then the multiple determinants of each controversy need to be made more transparent. It is also vitally important to learn lessons from history: an inadvertent consequence of EU GMO legislation and the high costs inherent in seeking regulatory approval has increased multi-national company monopoly in the commercial agricultural model. The Leopoldina *et al.* (2019) statement highlights the importance of increasing market competition by targeting incentives for smaller companies. Competition might also be enhanced by further exploration of the options for protecting intellectual property rights to take account of the issues for maintaining co-existence between breeder's rights and patents (EASAC, 2013). Plant Breeders Rights provides a well tried and tested system whereby breeders can secure financial returns on the release of a successful variety without jeopardising future societal benefits to be derived by even further genetic improvement that might be achieved by others.

It is beyond the scope of this short commentary to discuss in detail the varying public perceptions on genome editing in plants but it is worth mentioning that public surveys in the UK, commissioned on behalf of the Royal Society (van Mil *et al.* 2017)¹ demonstrate significant public support. For example, there was support for the use of genome editing to prevent crop damage by fungal diseases (77% of the group surveyed), to make crops more nutritious as a way of supplementing poor diets (70%) and in the biosynthesis of cheaper medicines (69%). Of course, these high approval ratings are expressed subject to necessary conditions: the use of genome editing as part of a package of solutions, with equitable access, no harm to the environment, publicly accessible information, effective regulation and ethical guidance in place.

It may be inferred that public opinion in many EU Member States is willing to consider the benefits of crop genome editing judging from the initiative of 14 countries, led by the Netherlands and Estonia. The advice from the Dutch agricultural ministry and others, following the ECJ ruling calls for the reform of GMO laws with regard to new breeding techniques, also observing that organisms obtained by mutagenesis have been used in farming for many years and have a long safety record². As emphasised recently by former EU Health Commissioner Vytenis Andriukaitis³, there is need for continuing dialogue with all sectors in society in the necessary rethinking of the cumbersome policy that currently deters new breeding techniques, *'yet this talk should not be at the expense of science and innovation'*. In the view of EASAC, dialogue does not need to continue to be primarily about the value of genome editing technologies, or GMOs, because this value is already demonstrable. Rather we need to debate about how the value of these technologies can be obtained for the EU and how the EU can contribute to achieving global food and nutrition security.

Other applications of new plant breeding techniques

Agricultural biotechnology, including genome editing, has potential to contribute to societal objectives in pursuit of the Bioeconomy in other ways in addition to food and nutrition security, for example in the search for the next generation bioenergy and in the biosynthesis of medicinal products, other high value chemicals and the building blocks for renewable industrial synthesis (see, for example, Tasis and O'Connor, 2016; Liu *et al.* 2017; Mortimer, 2019; Najera *et al.* 2019).

Summary of EASAC messages

EASAC endorses the Leopoldina *et al.* (2019) recommendations and now also reiterates our core recommendations on new breeding techniques from the previous EASAC work (2015, 2018):

- Products of new technologies and their use, rather than the technology itself, should be evaluated according to the scientific evidence base.
- The potential costs of not using a new technology, or being slow in adoption, must be acknowledged. There is no time to lose in resolving the problems for food and nutrition security in Europe.
- If a product of genome editing does not contain foreign DNA, it should not fall within the scope of EU legislation on GMOs.
- More broadly, there should be full transparency in disclosing the process used and the EU should seek to regulate the trait and/or product rather than the technology used in generating that product. That is, when considering safety issues, the focus should be on assessing whether the novel attributes of the plant might represent a risk to the environment or human health, irrespective of the breeding technique employed.
- The European Commission should continue to commit to supporting fundamental research in plant sciences to provide the tools and other resources for future innovation in plant breeding and farming practices.
- There is also continuing need for wide-ranging engagement to discuss critical, including ethical, issues to build trust between scientists and the public.

EASAC directs our messages to the European Commission, Council and Parliament and to policy makers in the Member States. The request by the European Council to the European Commission to clarify options to update the existing legislation might be interpreted minimally by some only as an examination of how to deal with products where the mode of molecular change cannot be detected, but in our view, this would then be a missed opportunity. The request from the Member States should rather be viewed as an invitation to the European Commission to set out

¹ This research involved use of focus groups with a broad demographic of participants plus a quantitative online survey ($n = 2,000$) to validate the dialogue findings.

² 14 EU countries call for 'unified approach' to gene editing in plants, www.euractiv.com, 24 May 2019.

³ Andriukaitis: Europe should take lead in science-based plant innovation, www.eurativ.com, 4 December 2019.

the strategic options for EU agricultural innovation and responsibilities in the wider international context, leading to a reopening of Directive 2001/18/EC. EASAC reaffirms the importance of exploring radical reform and urges the EU Institutions to explore the options recommended by Leopoldina *et al.* (2019) and others:

- First, to revise the GMO definition/exemptions to enable the EU to capitalise on the plant breeding opportunities afforded by genome editing.
- Secondly, to develop a new legal framework to focus on traits not processes.

Reform is needed urgently: if provision is not made soon for an evidence-based flexible and proportionate regulatory framework, there is little prospect of agricultural innovation realising its potential in achieving the Sustainable Development Goal targets by 2030 or of the EU maintaining international competitiveness.

Acknowledgements

Members of Council are thanked for their support for developing this commentary, expressed in the EASAC meeting in Zagreb, November 2019. We also thank individual experts for their advice, from previous EASAC Working Groups (in particular EASAC 2013, 2017b) and from the EASAC Biosciences Steering Panel. The commentary was drafted by the Biosciences Programme Director and Chairman.

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Its mission reflects the view of academies that science is central to many aspects of modern life and that an appreciation of the scientific dimension is a pre-requisite to wise policy-making. This view already underpins the work of many academies at national level. With the growing importance of the European Union as an arena for policy, academies recognise that the scope of their advisory functions needs to extend beyond the national to cover also the European level. Here it is often the case that a trans-European grouping can be more effective than a body from a single country. The academies of Europe have therefore formed EASAC so that they can speak with a common voice with the goal of building science into policy at EU level.

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The EASAC Council has 29 individual members – highly experienced scientists nominated one each by the national science academies of EU Member States, by the Academia Europaea and by ALLEA. The national science academies of Norway, Switzerland and the United Kingdom are also represented. The Council is supported by a professional Secretariat based at the Leopoldina, the German National Academy of Sciences, in Halle (Saale) and by a Brussels Office at the Royal Academies for Science and the Arts of Belgium. The Council agrees the initiation of projects, appoints members of working groups, reviews drafts and approves reports for publication.

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