This response was submitted to the Call for Evidence held by the Nuffield Council on Bioethics on Genome editing between 27 November 2015 and 1 February 2016. The views expressed are solely those of the respondent(s) and not those of the Council.

BSPB
promoting innovation

Nuffield Council on Bioethics – Genome Editing open call for evidence

Response from the British Society of Plant Breeders

Plant breeding has been identified as a major contributor to delivering the innovation in farming and food production that the world needs to address the well–known global challenges (food security, climate change, health, environment, economic growth). But plant breeding innovation is not happening fast enough to meet these challenges at the rate that the FAO and others say is needed. If plant breeders are to respond they need access to genetic resources, technologies, IP and investment operating synergistically within a system that is fair and equitable. Achieving this is the key to speeding innovation to meet the challenge. Genome editing technologies potentially have a significant role to play.

- <u>What is the current state of the art in the field? What are the current technical limitations and constraints/ bottlenecks?</u>

1. The first field crop varieties are in test where simple, well-known genes are involved. Commercial applications are limited at this stage to a herbicide tolerant variety of canola (spring oilseed rape) developed with oligonucleotide directed mutagenesis (ODM) (http://www.cibus.com/products.php). This is approved for the market in the US and Canada. Applications for marketing have been submitted in Europe but no final decisions taken. The EU Commission has asked Member States not to take decisions on the products of gene editing technologies pending its release of an interpretative document before the end of March 2016.
2. The technology has the potential to be used in plants to knock out gene function, change it, regulate gene expression or to incorporate new DNA sequences. The changes can be single edits or multiple edits in parallel. Knock out applications may be relatively simple; other opportunities will need a much more detailed understanding of gene function and regulation.
3. The potential has been proven in research:

    - A paper from Chinese scientists showed that it was possible to knock out the genes in wheat responsible for susceptibility to mildew to make plants resistant (*Yanpeng et al 2014 Simultaneous editing of three homeoalleles in hexaploid bread wheat confers heritable resistance to powdery mildew Nature Biotechnology 32 947-951*)

- At the John Innes Centre and Sainsbury Laboratory, researchers produced a mutation of the genes responsible for pre-harvest sprouting in barley and pod shatter in oilseed rape (both of which are a cause of crop losses). In both cases 1-6 bases of the gene were edited using CRISPR CAS9 and the mutated gene was shown to be transferred to the progeny. (*Lawrenson et al 2015 Induction of targeted heritable mutations in barley and Brassica oleracea using RNA-guided CAS9 nuclease Genome Biology 16:258*)

4. The technology may be more limited in its potential application than the recombinant DNA techniques that result in transgenic plants that are regulated as GMOs. That transgenic technology can produce results by transferring genes between species that would not be achievable using other techniques. The genome editing techniques lead to products that may be developed via other breeding techniques but do so with greater speed and precision and potentially lower cost.

- <u>What are the main directions of travel? What are the envisaged endpoints/ applications?</u>

5. The tremendous potential from the ability to target crop breeding to specific genes is the opportunity to speed up crop improvement, adaptation to climate change, genetic disease resistance and efficient use of natural resources (water, plant nutrients, land use). Genome editing can have applications leading to reduced food waste e.g. longer shelf life for fresh produce, reducing oxidative browning after processing or bruising in transport and better harvesting efficiency. The technology also offers new opportunity to remove traits that can cause problems, for example scientists at Rothamsted Research are applying genome editing techniques to develop wheat with very low levels of asparagine which would mean lower acrylamide levels; an issue of concern for the food industry.
6. These could all be achieved through classical plant breeding techniques but the time scale is far longer and the cost (excluding regulatory considerations) therefore much greater. Using genome editing techniques a plant breeder will be able to achieve a result in 2-3 years that would otherwise need 6-12 years or longer – or so long that it is not a viable proposition for investment.

- <u>What is the rate of travel? What are the expected timescales for realising the envisaged endpoints?</u>

7. Endpoints are hard to predict because underlying knowledge of many important crop genomes still requires further development to identify specific DNA sequences where genome editing can be applied.

- <u>Are gene drives an area of particular interest or concern and, if so, why?</u>

8. We are not aware of work being done with crop plants and gene drive.

Conditions of research and innovation

- <u>What are the main ‘drivers’ and ‘obstacles’ for plant genome editing in relation to envisaged endpoints?</u>

9. Plant genetic improvement is essential to ensure the secure supply of safe nutritious food to humanity whilst only using natural resources at a rate at which they can be replenished. Private sector plant breeders innovating in a competitive environment perceive the application of new techniques including genome editing as essential for their corporate survival. The drivers for the use of genome editing in plant breeding are greatly enhanced ability to develop products that provide consumer benefits in terms of food cost, safety and reduced environmental impact, speed to market, precision, and the need for success in a highly competitive market place.
10. The main obstacle at present is legal uncertainty about the way in which the products of genome editing techniques will be regulated. If it is decided that a European style GMO regulatory process must be applied to these products it will kill the potential for genome editing to be used to the benefit of European consumers. All companies and researchers need to have equal access to all technologies to be able to compete in delivering innovation through new crop varieties. Keeping access open to a diversity of companies means also supporting future investment in a broader diversity of crops and smaller markets. A costly regulatory system would put the technology out of reach for the smaller companies and public researchers, often those with the greatest interests in these markets. There could even be the potential for start-up plant science companies to work on these technologies for delivery through plant breeding companies, boosting investment and jobs.

- <u>What direct or indirect influence does historical public discussion surrounding genetic modification of plants have? What is (and what should be) the current level and focus of public debate?</u>

11. The application of new techniques at molecular level can easily become confused with transgenic technology (GMO) in the public debate. The GMO debate is clouded by political interests rather than remaining evidence-based, which has resulted in a *de facto* ban of GM in Europe and enhanced the global market power of breeding companies from outside the EU. If genome editing is similarly lost, then all that remains to address the societal challenges of sustainable food production is classical breeding. This is unlikely to be sufficient to address the challenges of growing population, urbanisation and climate change.
12. Already some NGOs have decided to oppose the technologies outright and have written open letters to the Commission and articles about ‘hidden GMOs’ have appeared in the press. We are in danger of walking into another GMO situation with polarised views and the risk of losing potentially step changing technologies for a public that believes it needs to be opposed without necessarily properly understanding what is at stake.

Outcomes

- What are the main anticipated benefits and costs (including safety and other risks) of genome-edited plants? In what ways, if any, are they significantly different from alternative GM technologies?

13. Again, the major anticipated benefit is faster breeding gain. Genome edited plants are significantly different to GM technologies in that GM involves insertion of inherited DNA. Genome editing creates new DNA sequences in the same ways as classical breeding, and is a much faster route to products that could over a very long time scale be developed through classical breeding techniques or mutagenesis that occurs in nature. Transgenic GM technology is about developing products that could not currently be achieved by any other technology through the insertion of DNA from other species.
14. With a positive regulatory attitude towards genome editing technology, Europe's consumers can benefit from faster development of more pest and disease resistant crop varieties with better nutritional and processing quality attributes which are more climate resilient and better for the environment. With an overly precautionary approach that regulates the products as GM, only consumers in other countries with a more positive attitude to innovation will benefit.
15. There are also consequences for R & D investment and jobs. The NBT platform has produced a fact sheet on the socio-economic impact of NBTs on the food supply chain in the EU http://www.nbtplatform.org/background-documents/factsheets/fact-sheet---social-economic-impact-of-nbts.pdf. In this they estimate that a loss of 30% of the R & D in the EU would mean a loss in investment in high level equipment and jobs amounting to €258 million.
16. It is necessary to regulate to assure public confidence but not to impede innovation when it is so urgently needed.

- Are there particular issues raised by genome editing in relation to ecological stability, biological diversity, technology transfer between countries, and equitable sharing of the benefits of research?

17. Biological diversity is essential for adapting to changing environment and evolution of plant pathogens. It is created by natural out pollination in sexual reproduction and by natural mutation. Classical breeding crossing and hybridisation increases the genetic variation available and selection methods at both phenotype and genotype level allow us to utilise that variation that is most useful. Private sector research in plant breeding for major crops suffers severe market failure in the absence of IP instruments such as PVP and Patents. Both instruments include research exemptions and guaranteed access to ensure balance between IP owners and users.
18. Genome editing has the potential to provide new varieties with optimised genes contributing to expanding the gene pool and making wider genetic variation available for plant breeding.

19. Other countries are taking decisions on genome editing and other new technologies and moving ahead, for example Argentina has recently published a regulatory system based on a pragmatic case by case approach. Differential regulation between the EU and other countries will extend the current trade issues created by different attitudes to GM to these newer techniques. An added complication is that many products will not be distinguishable as having been developed through a genome editing route which will only serve to increase difficulties in labelling, traceability and international trade.
20. If European companies and scientists are not able to use genome editing, the investment to date will be wasted. The science and the innovation in breeding will be exported to countries that are willing to embrace new developments and the results of the investment by the EU and its Member States will not be realised in products for the European market.

- To what extent, and in what way, does and should the distribution of anticipated benefits and costs of using genome editing in plants influence research and innovation?

21. Near market research is financed through seed markets. Research and innovation in plant breeding has to be market focused and anticipate sufficient return on investment or it cannot happen. Where societal benefits are only indirectly related to the economic value of crops, it is unlikely that market demand will focus research sufficiently on long term and uncertain outcomes from more complex traits such as C4 photosynthesis pathways in C3 species or symbiotic nitrogen fixation in species where that does not occur in nature. Such longer term research goals will continue to be led by researchers in the public sector, joining forces in public/private partnership projects with commercial plant breeders at an appropriate near market stage of the programme.

- To what extent are public and commercial interests in genome editing in plants complementary? In what circumstances might they come into conflict?

22. Private sector business models and value capture opportunities remain insufficient to support fundamental research and public research is essential to understand complex genetic traits and gene regulation. The benefits of that public research are delivered to society mainly through the plant varieties developed by the private sector and effective mechanisms for public/private partnership to transfer the results of strategic research at an appropriate point in the programme are essential. Public and commercial interests need to work together to realise the potential of the underpinning science through commercial plant varieties. The UK is strong in this area.

- What other important questions should or might we have asked in this section?

23. No answer.

24. This submission is made by the British Society of Plant Breeders (BSPB). BSPB is the representative association for public and private sector plant breeding in the UK. Its members are plant breeding companies ranging from large multinationals through pan-European companies to small and medium sized UK owned plant breeders and research institutes. BSPB provides services to its members in licensing and royalty collection, collection of farm-saved seed remuneration, organising statutory and non-statutory variety trials and representing the industry. BSPB is a member of the European Seed Association and the International Seed Federation. For more information go to:

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