European Commission

Scientific Advice Mechanism

Scoping paper:
New techniques in agricultural biotechnology

25 November, 2016

Research and Innovation

New techniques in agricultural biotechnology

Policy context

During the past decade a number of new techniques have been developed leading to organisms in which genetic material is altered compared to the initial organism. These techniques are attracting interest for their use in agriculture for plant and animal breeding. Many of these can also be used for microbial applications. A wide debate amongst stakeholders and the general public is ongoing within and outside the EU concerning the use in agriculture of organisms produced with these techniques, in particular relating to their comparison with 1) conventional breeding techniques and 2) established techniques of genetic modification. The use of some of these techniques in the field of synthetic biology and for gene drive can also be relevant for agricultural applications.

For the purpose of this scoping paper the terms:

- "established techniques of genetic modification in biotechnology" refers to various genetic engineering techniques which have been significantly used over the last 30 years to produce genetically modified organisms[1];
- "conventional breeding techniques" refers to traditionally used techniques[2]
- "new techniques" refers to techniques used in biotechnology other than those covered by the terms above. The term includes but is not limited to:
    - the techniques identified in the 2011 Member States' Expert Group report Oligonucleotide Directed Mutagenesis (ODM); Zinc Finger Nuclease (ZFN) Technology (ZFN-1, -2, -3); Cisgenesis and

[1] 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 and repealing Council Directive 90/220/EEC , OJ L 106, 17.4.2001, p. 1–39.

Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed, OJ L 268, 18.10.2003, p. 1–23.

[2] A wide range of techniques is used in conventional breeding. In its *Scientific Opinion addressing the safety assessment of plants developed using Zinc Finger Nuclease 3 and other Site-Directed Nucleases with similar function* (EFSA Journal 2012;10(10):2943), EFSA lists the following conventional plant breeding techniques as relevant for a comparison with plants developed by the SDN-3 technique: sexual crosses, bridge crosses, embryo rescue, somatic hybridisation, translocation breeding and mutation breeding. In animal breeding, in addition to natural mating, assisted reproductive techniques have contributed to genetic selection during past decades. In its *Scientific Opinion of the Scientific Committee on a request from the European Commission on Food Safety, Animal Health and Welfare and Environmental Impact of Animals derived from Cloning by Somatic Cell Nucleus Transfer (SCNT) and their Offspring and Products Obtained from those Animals* (EFSA Journal (2008) 767, 1-49) EFSA mentions the following technologies: artificial insemination from selected sires with its possible extension to sexed semen, oocyte collection from selected dams, embryo selection and transfer from selected genitors, *in vitro* fertilisation, and the long term storage of gametes and embryos.

Intragenesis; Agro-infiltration ("*senso stricto*" and "floral dip"); RNA-dependent DNA methylation (RdDM) and Reverse Breeding.

- more recent genome editing technologies, such as Transcription activator-like effector nucleases (TALEN), meganucleases and Clustered regularly interspaced short palindromic repeats (CRISPR).

- "synthetic biology" means the application of science, technology and engineering to facilitate and accelerate the design, manufacture and/or modification of genetic materials in living organisms[3].
- "gene drive" means stimulating biased inheritance of particular genes to alter entire populations.

Scientific advice previously requested by the Commission

The Commission has in the past obtained scientific advice on new breeding techniques.

1. The **study on "New Plant Breeding Techniques: state-of-the-art and prospects for commercial development"** carried out by the Commission's Joint Research Centre (JRC). The study (report published in 2011[4]) investigates the degree of development and adoption by the commercial breeding sector of new plant breeding techniques, discusses drivers and constraints for further developments and evaluates the technical possibilities for detecting and identifying crops produced by new plant breeding techniques.

2. A Member States' Expert Group established a **list of new plant breeding techniques** and evaluated them in the light of the existing legislation and of the most recent available scientific data. The Expert Group also addressed synthetic biology applications, but provided a very limited analysis on this topic. The group finalised its report in December 2011[5], but could not reach a consensus on all techniques.

3. The EFSA Panel on GMOs adopted **scientific opinions on three techniques**, namely cisgenesis, intragenesis and site directed nucleases technique, in terms of the risks they might pose and the applicability of the existing EFSA guidance

[3] SCENIHR, SCCS, SCHER (2014) Synthetic Biology I Definition, Opinion, September 2014. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_044.pdf

[4] http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4100

[5] New Techniques Working Group FINAL REPORT

documents on GM plants for their risk assessment. EFSA's opinions have been published in 2012[6].

4. The three Scientific Committees SCHER, SCENIHR and SCCS, upon request from the Commission, published three **opinions on synthetic biology**, focusing on its scope and definition, risk assessment methodologies and safety aspects and research priorities[7].

This previous advice is focussed on new techniques for plant breeding as well as on synthetic biology and provides a good basis and relevant information in relation to these subjects. However, considering the rapid and recent developments in the field, and the broader scope of the possible applications of the new techniques in agricultural biotechnology, which also concern the application of these techniques to animals and micro-organisms, an up-to-date explanatory note/opinion and scientific advice are requested to the SAM HLG as described below.

Request to SAM HLG

SAM HLG is asked in the first instance and by March 2017 to provide an explanatory note on *new techniques in agricultural biotechnology* including their potential agricultural application in synthetic biology and for gene drive, taking into consideration the most recent developments in the agricultural sector. The explanations concerning questions 1 and 2 as specified below should be in scientific terms and should not examine legal issues.

1. Key characteristics of the various new techniques

   SAM HLG is asked to provide an up-to-date overview on new techniques in agricultural biotechnology, whether ready to be used for commercial purposes or still at development stage, and on the key characteristics of each of these techniques (such as underlying molecular mechanism and products obtained). SAM HLG is also requested to describe potential agricultural applications of new techniques in the field of synthetic biology and gene drives.

[6] EFSA Journal 2012;10(2):2561, EFSA Journal 2012;10(10):2943

[7] SCENIHR, SCCS, SCHER (2014) Synthetic Biology I Definition, Opinion, September 2014. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_044.pdf

SCENIHR, SCCS, SCHER (2015) Synthetic Biology II - Risk assessment methodologies and safety aspects, Opinion, May 2015. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_048.pdf

SCENIHR, SCCS, SCHER (2015) Synthetic Biology III – Research priorities, Opinion, December 2015. Available from: http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_050.pdf

2. Comparison with established techniques

   SAM HLG is asked to explain the differences and similarities of each new technique as compared to 1) established techniques of genetic modification and 2) conventional breeding techniques. Where possible, differences and similarities should be identified in terms of safety for health and environment, possibilities for detection of the respective products, speed and cost to achieve the expected result and degree of maturity for field applications. Where published scientific evidence is insufficient, this should be explicitly stated.

In view of the timeframe in addressing questions 1 and 2 the explanatory note will be based on published literature reviews, scientific reports and existing published opinions which will be identified using a systematic and transparent procedure.

In a second phase, SAM may subsequently be asked to supplement this work by describing expected trends in the next decade in agricultural biotechnology for plant and animal breeding, and for micro-organisms, and to anticipate forthcoming developments in the agricultural sector. This could include for example the anticipated development of further new techniques for synthetic biology and gene drive. The content and questions of the second phase will be specified based on the outcome of the first phase and in a second scoping paper.

In view of the likely public interest in the present topic, during the potential second phase, the Commission may involve other relevant expert groups to explore linked societal issues, which may include the aspects of public perception of agricultural biotechnology and of public engagement in the development of related scientific advice.

Further actors in support of the SAM HLG

EU academies and the wider scientific community may be consulted to collect scientific evidence and input.