

National Organic Standards Board
Materials Subcommittee Excluded Methods Discussion Document
Induced Mutagenesis and Embryo Transfer in Livestock
February 12, 2019

SUMMARY

The Materials Subcommittee invites public comment on this discussion document to determine if induced mutagenesis and embryo transfer should be allowed or excluded from organic production. Induced mutagenesis can be accomplished through a variety of activities, with some possibly acceptable and some not. Embryo transfer in livestock, with its accompanying possible use of synthetic hormones and its by-pass of traditional breeding methods, presents its own challenges. The Materials Subcommittee invites the public to answer the questions posed at the end of this discussion document, as well as to present other issues that may not have been considered in the questions listed.

DEFINITIONS AND CRITERIA

Under the National Organic Program organic regulations, methods that employ genetic engineering techniques are excluded from use in organic production. The current regulation defines an excluded method as:

A variety of methods used to genetically modify organisms or influence their growth and development by means that are not possible under natural conditions or processes and are not considered compatible with organic production. Such methods include cell fusion, microencapsulation and macroencapsulation, and recombinant DNA technology (including gene deletion, gene doubling, introducing a foreign gene, and changing the positions of genes when achieved by recombinant DNA technology). Such methods do not include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture.

In 2016 the NOSB recommended the following criteria be used to assess emerging technologies and determine if they should be excluded from organic production:

- 1. The genome is respected as an indivisible entity, and technical/physical insertion, deletions, or rearrangements in the genome is refrained from (e.g. through transmission of isolated DNA, RNA, or proteins). In vitro nucleic acid techniques are considered to be invasion into the plant genome.*
- 2. The ability of a variety to reproduce in species-specific manner has to be maintained, and genetic use restriction technologies are refrained from (e.g. Terminator technology).*
- 3. Novel proteins and other molecules produced from modern biotechnology must be prevented from being introduced into the agro-ecosystem and into the organic food supply.*
- 4. The exchange of genetic resources is encouraged. In order to ensure farmers have a legal avenue to save seed and plant breeders have access to germplasm for research and developing new varieties, the application of restrictive intellectual property protection (e.g., utility patents and licensing agreements that restrict such uses to living organisms, their metabolites, gene sequences or breeding processes) are refrained from.*

The NOSB recommended the following methods be excluded from use in organic production:

- *Sequence-specific nucleases (SSNs)*
- *Meganucleases Zinc finger nuclease (ZFN)*
- *Mutagenesis via Oligonucleotides*
- *CRISPR-Cas system (Clustered regularly interspaced short palindromic repeats) and associated protein genes*
- *TALENs (Transcription activator-like effector nucleases)*
- *Oligonucleotide directed mutagenesis (ODM) Rapid Trait Development System*
- *RNA-dependent DNA methylation (RdDM)*
- *Silencing via RNAi pathway RNAi pesticides*
- *Reverse breeding*
- *Genome elimination*
- *FasTrack*
- *Fast flowering*
- *Creating new DNA sequences*
- *Synthetic chromosomes*
- *Engineered biological functions and systems*
- *Somatic nuclear transfer*
- *Plastid transformation*
- *Cisgenesis*
- *Intragenesis*
- *Agro-infiltration*

BACKGROUND

As the NOSB continues to work through the list of methods “to be determined” as excluded or not for organic production, the determinations become more difficult to categorize. The Materials Subcommittee seeks public comment to aid in understanding the technologies and how they might be determined using our current criteria describing genetic engineering methods.

Induced or Directed Mutagenesis

Mutations that suddenly occur in nature under natural conditions are known as spontaneous mutations. These are typically rare events. Spontaneous mutations result from a biological process, or from mutagenic agents present in the environment (i.e. cosmic rays, heat, starvation) that change the structure of DNA. That mutation can be an atypical recombination, an atypical segregation, a removal of an amino group from an amino acid, or serious damage to the DNA caused by the breaking of covalent bonds that release nucleic acid components guanine or adenine from DNA.

Induced mutations are the result of human interference and can be accomplished through physical agents, such as ultraviolet light, x-rays, heat, irradiation and/or chemical agents (i.e. mustard gas, ethylene amine, and others). Induced mutations can be both random and targeted through a variety of genetic engineering techniques. Epigenetics, where gene expression can be altered rather than an alteration of the genetic code itself, can be the result of induced mutagenesis. The various induced mutagenesis techniques that turn on or off genes or combinations of genes for a desired effect needs to be reviewed. Transposon, or jumping genes in which genes move from one location to another and

cause change to both the new location and the old location, can also be caused by induced mutagenesis. The changes found in spontaneous mutagenesis listed above can also be produced through induced mutagenesis.

Determining whether induced mutagenesis should be considered a genetically engineered plant (genetic engineering is referred to under the NOP regulations as an excluded method), was decided by the [Court of Justice of the European Union on 25, July 2018](#). In short, the ruling determined that induced mutagenesis techniques, which make it possible to alter the genome of a living species without the insertion of foreign DNA, are to be considered genetically modified organisms. The decision did allow individual states within the EU to determine if older methods of mutagenesis, those that have been used conventionally, have a long safety record, and that did not include “in vitro” engineering techniques, might not be considered to be genetic engineering. According to Codex, all gene editing that is based upon invasive nucleic activity is considered genetic engineering or the product of modern biotechnology.

Embryo Transfer in Livestock

Embryo transfer in livestock is the process of removing one or more embryos from the reproductive tract of a donor female and transferring them to one or more recipient females. In order to accomplish this transfer, one or more of the following may occur:

- The embryo may have been produced in a laboratory using in vitro fertilization techniques.
- The embryo may have been produced in a laboratory using somatic cell cloning techniques.
- The donor female may have been treated with GnRH (Gonadotrophin-Releasing Hormone) that results in superovulation, producing numerous donor eggs instead of one or two, and those embryos were harvested from that female.
- The receiving female may have been treated with prostaglandin (brand name: Lutalyse) to synchronize estrus (heat) to improve the implantation success of the donated embryo.
- Collection and insemination of embryos is done through use of stylets or pipettes.
- Evaluation and short-term storage of embryos.
- Micro-manipulation and genetic testing of embryos.
- Freezing of embryos.

Embryo transfer in bovines was developed commercially in the 1970s and 1980s but has been performed experimentally since 1890 on many types of livestock. This technique is performed for a variety of reasons, including:

- a. An animal has a biological or physical impediment to natural fertilization, such as scarring on the ovaries, which prevents the eggs from being released and fertilized.
- b. The livestock producer seeks to improve their herd by focusing on the eggs and sperm of individuals that have desired characteristics.

Currently, some NOP accredited certifiers are allowing embryo transfer into organic cattle if the receiving animal was not treated with prostaglandin. The donor animal most likely had been treated with GnRH. There is some research detailing the short- and long-term effects of the use of both prostaglandin and GnRH in beef and dairy cows and their off-spring. Use of embryo transfer might be a way to accelerate the inclusion of desired traits into a herd, such as cows that produce A2A2 proteins in their milk or polled livestock (livestock that typically have horns, are born without horns), which lessens the need for the invasive procedure of dehorning on young animals.

DISCUSSION QUESTIONS

Induced or Directed Mutagenesis

1. Using the NOSB recommendation on the criteria to determine a technology as genetic engineering (listed above), please provide information on which technologies that result in induced mutagenesis could be considered an excluded method under organic production and why?
These would include induced mutagenesis caused by irradiation, x-rays, heat, UV light, and a variety of chemicals.
2. Using the NOSB recommendation on the criteria to determine a technology as genetic engineering, please provide information on which technologies that result in induced mutagenesis could be considered not an excluded method under organic production and why?
These would include induced mutagenesis caused by irradiation, x-rays, heat UV light, and a variety of chemicals.
3. Should the random or targeted aspects of induced mutagenesis be considered when determining if a technology should be excluded.?
4. How do epigenetic implications affect the determination of whether the method is to be excluded? Are there some types of epigenetic methods that could be allowed or not allowed?
5. Would there be any effects on currently accepted varieties, cultivars, or breeds if induced mutagenesis was determined to be excluded? Be specific.
6. Are there types of induced mutagenesis that are highly beneficial to organic production or highly problematic?

Embryo Transfer in Livestock

1. Should the use of hormones to stimulate egg production be allowed in donor animals?
2. Should the use of hormones to synchronize estrus in animals who will receive the embryo be allowed?
3. Are there concerns for the health of the adult animal or their offspring after the use or repeated use of these hormones?
4. Could the approval of this technology have any unintended consequences, such as the narrowing of the gene pool, due to widespread use of embryos from a narrow pool of egg and sperm donors in organic production?
5. Is embryo transfer a necessary method for organic livestock production?

Subcommittee Vote

Motion to accept the discussion document on induced mutagenesis and embryo transfer in livestock

Motion by: Harriet Behar

Seconded by: Dan Seitz

Yes: 5 No: 0 Absent: 0 Abstain: 0 Recuse: 0

Approved by Emily Oakley, Subcommittee Chair to transmit to NOSB, February 13, 2019