

The potential benefits of genome editing in farm animals

A need to revise the E U regulation

Потенциалните ползи от редактирането на генома при селскостопански животни

Необходимост от преразглеждане на регламента за ЕС

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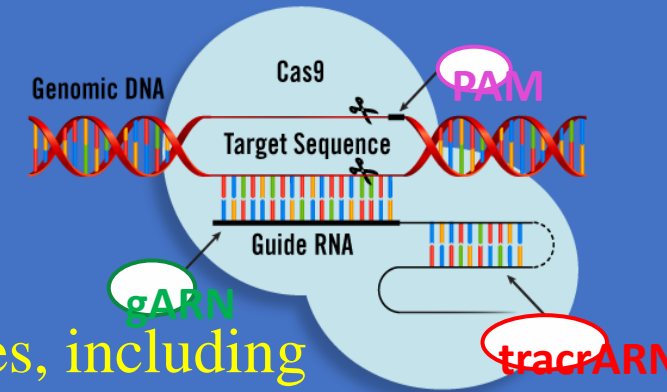
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INTRODUCTION



- The *Nobel Prize in Chemistry 2020* was awarded jointly to Emmanuelle Charpentier and Jennifer A. Doudna "for the development of a method for genome editing. They have discovered one of gene technology's sharpest tools: the CRISPR/Cas9 genetic scissors.
- "Genome editing, is a group of mutation technologies that allow modification of genetic information by adding, removing, or altering DNA sequences at a **specific** location in the genome in a targeted way".
- **Precise** genome editing, using of site directed nucleases such as the CRISPR system, has spread rapidly through the biological sciences and its application to livestock is nowadays possible since the CRISPR revolution.

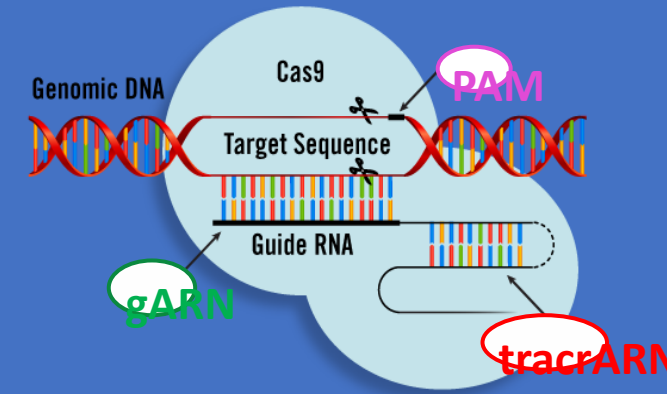
INTRODUCTION (2)



- Genome editing in large animals may be applied with different purposes, including biotechnology to improve food production, animal health and pest control, and the generation of animal models for biomedicine and basic research.
- The main question for an innovative technology is why it should be used?
- In livestock, the global context of food demand and production, as well as new concerns in terms of environmental sustainability, and animal welfare, may explain the potential usefulness of CRISPR.
- In regards to the great benefits to the farm industry and the society as a whole, it is fair to mention that controversies and consensus, opportunities and threats, benefits and risks, ethics and science should be considered to enter into the CRISPR era (not here dealt with because of lack of time).

OUTLINE

- 1. LIVESTOCK APPLICATIONS
- 2. THE CURRENT E U REGULATION
- 3. THE POSITION PAPERS OF THE TWO FRENCH ACADEMIES :
VÉTÉRINAIRE AND OF AGRICULTURE DE FRANCE



1. Livestock applications



The four main applications of gene editing by CRISPR Cas9 in livestock:

- **Disease-resistant animals** : prophylactic measures of the 21st century,

Best examples of effectiveness : - Porcine Reproductive and respiratory syndrome (PRRS) and Classical Swine Fever : pigs of several generations on the ground in USA and China, bovine Tuberculosis: on the ground in China

- African Swine Fever under active investigation

- Improving productive traits : Muscle development and body growth economic benefit for farmers, in sheep (in Uruguay), cattle (USA), carp (China), pig and goat (China, South Korea).
- Improving animal welfare : Hornless cattle, Limiting heat loss (swine) + germline ablated male pigs gender etc..
- Large animals models in research and biomedicine including xenotransplantation

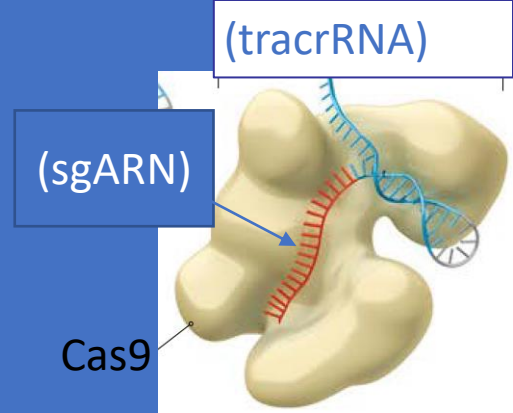
2. The current regulation of GMO's and Gene Edited Organisms (G E O) in Europe



Dramatic contrast between the European position on genome editing and those of all other countries in the world:

- On 25 July 2018, the Court of Justice of the European Union ('the Court') decided that organisms obtained by the new techniques of directed mutagenesis are genetically modified organisms (GMOs), within the meaning of the Directive 2001/18/EC on the release of genetically modified organisms into the environment ('GMO Directive') and that they are subject to the obligations laid down by the GMO Directive.
- Current European regulations are an obstacle to developing them and need to be revised so that France and EU do not give up on their agrifood independence
- The situation of European genome editing research is also of major concern. More than 80% of the patents filed on applications of the CRISPR-Cas technique are American or Chinese and less than 10% European. This is a disastrous situation,

2. The current regulations of GMO's and Gene Edited Organisms (G E O) in Europe



- **Current European regulations are an obstacle to developing new Genome Editing techniques and need to be revised** so that France and EU do not give up on their agri food independence,
- Even though biotechnologies are used for medical purposes in EU (European Union), they are practically refused for their agricultural applications, in spite of the results observed in 26 countries worldwide and the prospects opened by the techniques of genome editing ,
- Already many countries have applied this technology and consider that for genome editing products obtained by Site Directed Nucleases 1 and 2 (minor genome modifications), there is no need to apply GMO regulations. This is notably the case of the United States, Canada, Argentina, Colombia, Chile and Brazil, Israel, Australia, Japan. The characteristics of the marketed product are evaluated on a case-by-case basis, regardless of the production technique.

2. The current regulations of GMO's and Gene Edited Organisms (G E O) in Europe

- Voices have already been raised for the products obtained by genome editing to be subject to appropriate European regulations. This is noticeably the key point of the comments of the E U Scientific Advice Mechanism (SAM),
- Current reflections ongoing in the E U Commission
- What have been the contributions of the French Academies : Vétérinaire and of Agriculture ?



3. The Position Papers of the French Academies : Vétérinaire and of Agriculture



3.1. Académie Vétérinaire de France (www.academie-veterinaire-defrance.org)

- This Académie has focused its “Avis” on research and the three recommendations are as follows:
- **recommends** that **research projects** making use of modern genome engineering technologies be encouraged at all levels and adequately funded,
- **recommends** that **Community legislation** adapted to the case of genetically modified domestic animals should rapidly be introduced in order to establish a regulatory framework which is a function of the type of genetic modification and takes account of the rapid evolution of the technology in this field, so as to foster innovation
- **recommends** that projects relating to the production or importation of domestic animals whose genomes have been modified by editing certain segments of DNA should be examined on a **case-by-case basis** by the competent authorities and subject to a scientifically sound basis, also taking into account an analysis of the degree of acceptability by society.

3. The Position Papers of the French Academies: Vétérinaire and of Agriculture



3.2. Académie d'Agriculture de France (www.academie-agriculture.fr)

This Académie has widened its scope and its title is : **GENOME EDITING, ETHICS AND TRUST**. It makes seven recommendations in 4 chapters and one suggestion:

I.- Act responsibly.

- 38 R1.1 Consider that each operation, for purposes other than research, aimed at the release of plants or animals having had their genome edited is a particular case,

II.- Respect the principle of precaution.

- 43 R2.1 Maintain the principle of an authorization prior to any release after editing the genome, but with better calibrated dossiers

III.- Engage the public. Inform the Society. Act transparently.

- 46 R3.1 Imagine new means, methods and places of debate to - train and inform the public in a transparent manner, - and associate them with authorization decisions

3. The position Papers of the French Academies Vétérinaire and of Agriculture



3.2. Académie d'Agriculture de France (www.academie-agriculture.fr)

IV.- Re-evaluate regularly

- 48 R4.1 Apply to the cases mentioned here above in R1.2, the differentiated procedure of article 7 of the "Directive 2001/18 / EC on the deliberate release into the environment of genetically modified organisms".

One suggestion :

- 50 R4.2 More generally, in the context of unprecedented scientific and technological leaps and strong societal expectations, provide for a revision every 7 years of texts both at national and European level. The AAF, for its part, wishes to contribute to this development and, to do this, is ready to solicit and support legislators, in conjunction with other French and European academies.

Conclusion (1)

- Addressing sustainability for society, the genome editing is promising to meet the current challenges of food production of quality which is in strong growth and demand globally while preserving the environment.
- Breeders now have effective tools to induce targeted mutations of genomes of great interest to the animal breeders in terms of production, of food safety or else of animal health and animal welfare,

Conclusion (2)

- Current European regulations are an **obstacle** to developing new Genome Editing techniques and need to be revised in order to create a favorable regulatory environment for innovation, so that the European society can benefit from new science and technology.
- « Those who excessively restrict biotechnology today will pay-per-use tomorrow ». The Europeans should decide on which side the future will find us.
- This revision should take into account that the Risk analysis “should be examined on a **case-by-case basis** by the competent authorities and subject to a scientifically sound basis, also taking into account an analysis of the degree of acceptability by society”.