Case study on „New gene-editing techniques: a focus on CRISPR-Cas9 gene drives“

Case study introduction

This case study investigates the application of the precautionary principle in relation to gene drives. Gene drives are a technique with the potential to rapidly alter the genetic make-up of a population or even species.

Gene drives occur naturally, and with the introduction of the genetic modification technique CRISPR-cas9, there is now a way to create them synthetically as well. Gene drives can be designed in such a way that they suppress or replace a native population. Examples of envisioned uses of gene drives are the eradication of vector-borne diseases such as malaria or dengue, the promotion of agricultural stability and control of invasive species. As such, gene drives can be used for agricultural, public health or environmental goals.

Thus far, gene drives research has focused on yeast, fruit flies and several species of mosquitoes.

Gene drive technology involves both uncertain opportunities and uncertain risks.

Relevance to the precautionary principle

The precautionary principle is important in the context of gene drives. The technology introduces permanent genetic changes into wild animal and plant populations. The overall effects of the alteration or elimination of a population on the environment in which these organisms operate is often unknown. Thus, there is a high degree of epistemic uncertainty surrounding the impact of gene drives. At the same time, the technology poses serious and unknown risks. Problematically, investigations into the risks of gene drives come with considerable risks themselves.

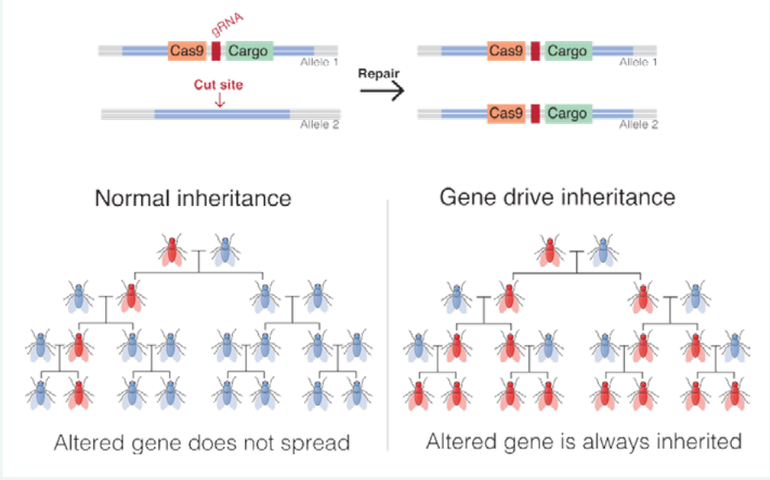
There is consensus amongst gene drive researchers, policy makers and other stakeholders that application of the precautionary principle is in order. Differences in views exist, however, on how the principle should be applied. Currently, no country has regulations in place for the release of a gene drive.

Gene drives are designed to spread, invade and persist in the environment.

Potential impact

The benefits as well as the risks of a gene drive depend on both the type of modification and the organism that is modified. One of the greatest assumed benefits is the sustained, durable genetic change that is induced by gene drives. Additional benefits are the rapid effects targeted at a specific population and the ability to reach remote areas that are difficult to access, since gene drives spread themselves. Another advantage mentioned is that once released, all individuals living near a release site will benefit equally. For instance, if a gene drive designed to eliminate malaria is released, the entire population in that area will benefit from the elimination.

The potential of a genetically altered trait to spread and invade is at the same time perceived as one of the largest risks. The alteration of a population might bring about unforeseen and unknowable consequences that, due to the invasive nature of gene drives, are difficult to halt or reverse. This can have repercussions for the whole ecosystem; for instance if food production systems are disrupted as a result of the depletion of an animal in the ecological food chain.



Other risks include potential non-target impacts due to an increase in mutations induced by CRISPR-cas9. An additional worry is that of gene flow, where modified genes of one species are transmitted into the gene pool of another. This could result in unwanted genetic modifications of other species.

Finally, a risk is the deliberately malicious use (dual use) of gene drives. For instance, just as mosquitos can be made unfit for carrying malaria, they can plausibly be designed to carry and spread an extra lethal cargo using gene drives. Given the relative accessibility of CRISPR-cas9 as a technique, this is a risk that is difficult to regulate.

Key uncertainties

Gene drives are accompanied by a high degree of uncertainty. It is uncertain what the ecological effects of a gene drive release are, and if these effects can be halted and/or reversed.

The interaction between gene drives and the environment is an uncharted field of research. At the same time, these interactions cannot be investigated in a confined (laboratory) environment. Therefore, investigations into the interactions and the effects of gene drives on the environment cannot be done without releasing a gene drive in open field trials, which themselves come with considerable, unknown, risks.

Investigations into environmental effects cannot be done without releasing a gene drive in open field trials, which itself comes with risks.

Further information

Rathenau Institute
www.rathenau.nl/en

Author:
Rosanne Edelenbosch, *Researcher*

Author of the factsheet:
Isabelle Pirson, MSc, MA

For the **references** used for the case study, please look into the full report available at:
www.recipes-project.eu/results/case-study-new-gene-editing-techniques-crispr-cas9

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