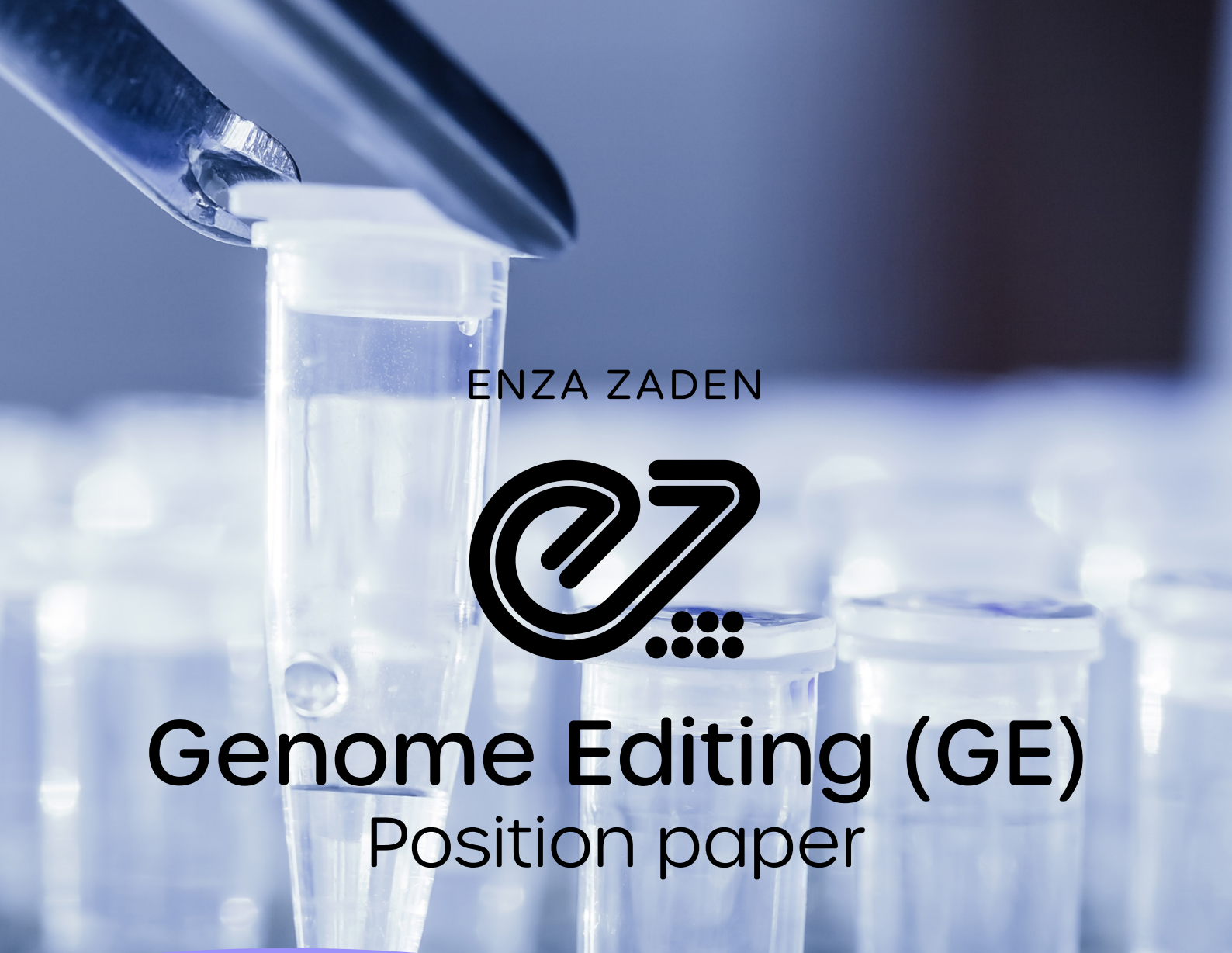

ENZA ZADEN

Genome Editing (GE)

Position paper

Genome Editing (GE), also called Gene Editing,
is becoming a trending topic within society.
In this position paper we explain how Enza Zaden
looks at this new technology.

Genome Editing (GE), August 2023

Societal context

Food security is one of our global societal challenges, both in the context of feeding an increasing world population as well as addressing the demand for varied and healthy food. For the next 30 years, we will need to secure the global availability of healthy food and decrease the environmental impact of agriculture. In order to do so, we must integrate new technologies to accelerate the development of novel crop varieties and sustainable farming practices.

GE is interesting for Enza Zaden, as this technology could accelerate the rate of genetic gain in our vegetable breeding (e.g. increased yield, resistance to pests, adaptation to climate change) and provide improved quality of fruits and vegetables (e.g. taste, nutrition or shelf-life). Therefore, it is important to explore the potential of this technology on a research basis to evaluate its applicability for our genetics and processes.

Example 1 Exploring the potential of this technology (current situation)
Plant pests can lead to huge losses in crop production. At Enza Zaden, we are researching whether GE could help us identify genes that provide disease resistance in our crops, and further translate these learnings to our breeding pipelines by searching for natural genetic variants in these key genes within in our gene bank.

Example 2 Deliberately use this technology (future situation)
An Enza Zaden researcher has found a scientific paper describing the effect of a gene on tomato fruit production. To test whether this gene could be used for our breeding programs, we could apply GE to quickly make the required mutations in a tomato line and evaluate if it increases fruit production. If it looks interesting, we can use natural genetic variants from the gene bank to bring this trait into our varieties. Alternatively, we could choose to directly commercialise the GE-ed line in markets where GE is de-regulated.in markets where GE is de-regulated.

Currently, Enza Zaden is testing the potential application/use of GE technology for our research programs in several crops but we do not apply it for our commercial product development. When relevant, we will consider the use of GE technology for our variety development and direct commercialisation, depending on whether it would help us maintain our competitive edge. However, we will take careful steps to explore this direction not only from the technology but also the regulatory and societal perspective and inform our employees and external stakeholders if we decide to go for GE product commercialisation.

Technical context

Genome editing is a collection of biotechnology tools that can make precise and targeted mutations in the genome (DNA) of an organism, plant or animal (including human). Although several different GE systems have been developed in the last two decades, the most popular one is the CRISPR-enzyme system (e.g. CRIPR-CAS9, CRISPR-CPF1). CRISPR-enzyme was discovered in 2014 as a naturally occurring mechanism in bacteria to defend themselves against viruses and due to its simplicity, low cost and high efficiency it is the most widely used.

The fundaments of CRISPR-enzyme are the 2 components: a genomic GPS system that finds the exact sequence in the genome and an endonuclease or DNA scissor, which makes a cut in the DNA. After this cut occurs, the cell internal/native repair machinery will want to close the break in the DNA, and this process leaves mutations in the DNA site. The process of DNA repair is the same as for example after sun UV rays or any mutagenic agent that can induce DNA breaks in cells.

In the past 6 years, the plant, animal and medical scientific communities have applied the CRISPR-enzyme technique successfully in a wide variety of species, and shown its potential to address genetic diseases, such as muscle dystrophia and blindness, as well as challenges in crop performance, for example for disease resistance and product shelf-life.