COULD GENE DRIVE TECHNOLOGY BE APPLIED TO AGRICULTURE?

Gene drive is a genetic phenomenon that occurs in nature and causes a selected trait to spread through a species via sexual reproduction over several generations, with an inheritance rate each generation that is higher than the Mendelian rate of 50%. Researchers are currently investigating the use of gene drives mainly for public health and conservation applications. Gene drive approaches could, in principle, be applied to other species with short generation times that reproduce sexually, including agricultural pests. Because of the significant negative impact of weed and invertebrate pests, and agricultural diseases, there has been growing interest in using genetic techniques, including gene drive, to control these organisms.

Are gene drive approaches being investigated for agriculture applications?

Gene drive research is largely focused on applications that would be useful for public health (vector-borne diseases) and conservation (such as controlling invasive alien species). There has been some early investigation of possible other uses and gene drive elements have been implemented in lab-based experiments involving a handful of pest species. For example, research into agricultural pests such as Drosophila suzukii, a significant pest of several species of soft-skinned fruits, has emerged in the last few years.[1] There are ongoing efforts to implement gene drive in rodents that threaten crops[2].

As with many technologies, there are a wide range of possible uses that can be investigated. Not all will be possible, successful or desirable. **But any technology derived from gene drive research will be subject to review and approval by regulatory authorities before it can be considered for use.**

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The impact of pests in agriculture

- According to FAO every year up to 40% of world crop production is lost due to agricultural pests, and plant diseases cost the global economy over $220 billion. (FAO Scientific review of the impact of climate change on plant pests, 2021).
- A report of the Royal Botanic Gardens-Kew estimates that the spread of pests and pathogens that damage plant life could cost global agriculture $540 billion a year (State of the World's Plants Report, RBG Kew. 2017).
- Researchers have estimated that agricultural pests cause a decrease in production of approximately 10 percent to 28 percent for wheat, as well as rice losses of 25 percent to 41 percent and maize losses of 20 percent to 41 percent. (Nature, Ecology and Evolution, 2021)

How could gene drive be used in agriculture?

Integrated pest management strategies, which can include the use of pesticides, are currently the main tool for the control of pest species (such as weeds and insects) in much of agricultural production. Although existing tools have contributed to notable improvements in reducing food loss and waste, farmers are still losing a significant part of their production to pest infestations. In addition, the growing incidence of pesticide resistance among many species is an increasingly urgent problem. There is ongoing research in new tools to help protect crops and minimise agriculture's environmental footprint, looking at a wide range of tools and practices, including those that would leverage advances in gene editing techniques.

Researchers are in the early stages of exploring gene drive-based strategies to help reduce the populations of agricultural pests. For now, these strategies have mainly focused on the control of pests that damage or compete with crops, or carry disease.

In theory, gene drive approaches could also be explored in some cases to spread desired traits in crops and livestock faster than traditional breeding. However, this option has significant limits because gene drives cannot alter asexually reproducing organisms, which include many plants grown for food, and are not suitable for species with long generation times.[3]

Like for any other use of gene drive, determining what is the best tool to solve the issue at hand is the first step. Gene drive approaches may or may not meet these needs and requirements which is why a case by case assessment is needed to determine whether it could be a worthwhile approach to investigate.

[1]Buchman, A., Marshall, J. M., Ostrovski, D., Yang, T., & Akbari, O. S. (2018). Synthetically engineered Medea gene drive system in the worldwide crop pest Drosophila suzukii. Proceedings of the National Academy of Sciences, 115, 4725–4730.

[2]Gene drive strategies of pest control in agricultural systems: Challenges and opportunities, 2021

[3]Esvelt, Kevin M et al."concerning RNA-guided gene drives for the alteration of wild populations"eLifevol. 3 e03401. 17 Jul. 2014

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