

The Science and Ethics of Gene Drive Technology

A preliminary foresight analysis

Gene Drive and Malaria: the case of Target Malaria



Malaria: some facts

- Transmitted by female *Anopheles* mosquitoes
- 219 million cases globally in 2017
- 435 000 deaths globally in 2017
 - 266 000 were children under 5
- No significant progress in 2015-2017 period
- The required funds are predicted to rise from \$5.1 billion in 2017 to \$9 billion per year by 2030
 - Funds actually available reached only \$3.1 billion.
- Consensus: we need new tools*

*https://www.who.int/malaria/world_malaria_report_2010/en/

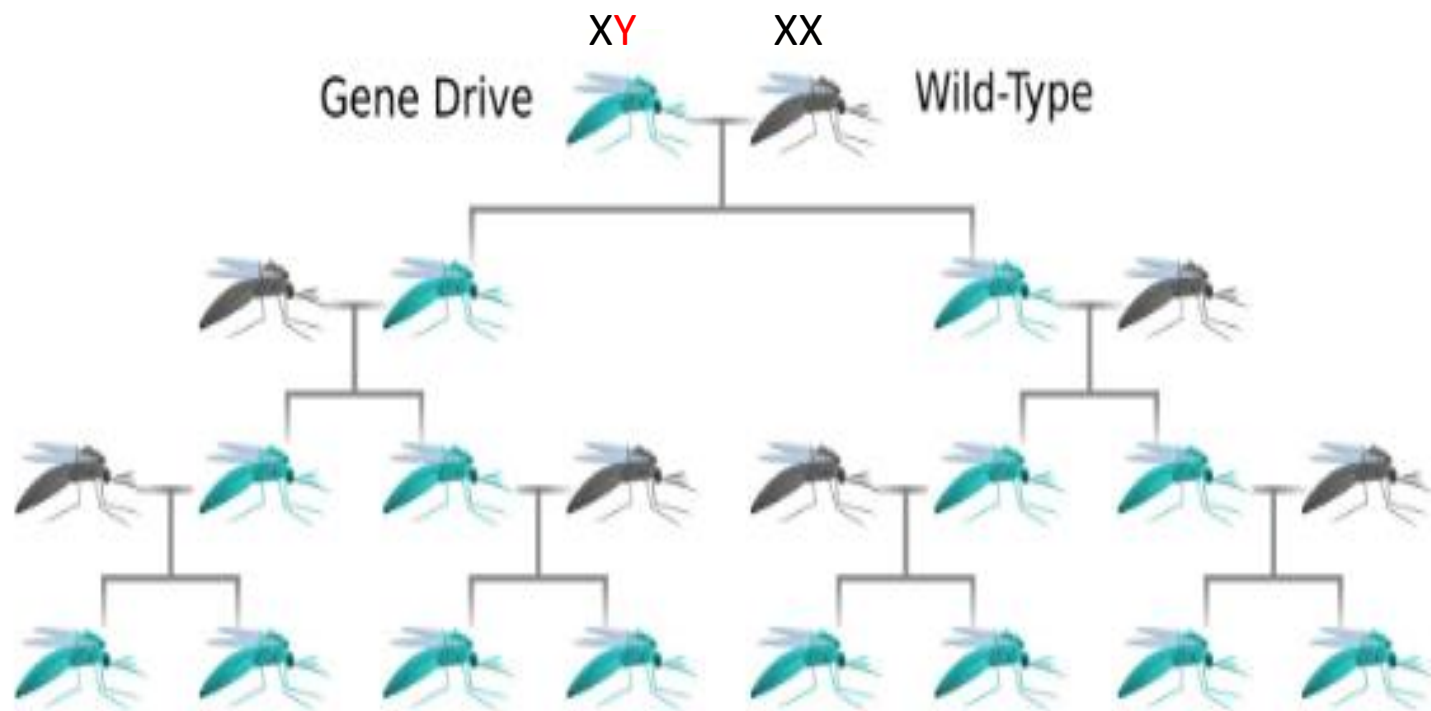
Gene Drive

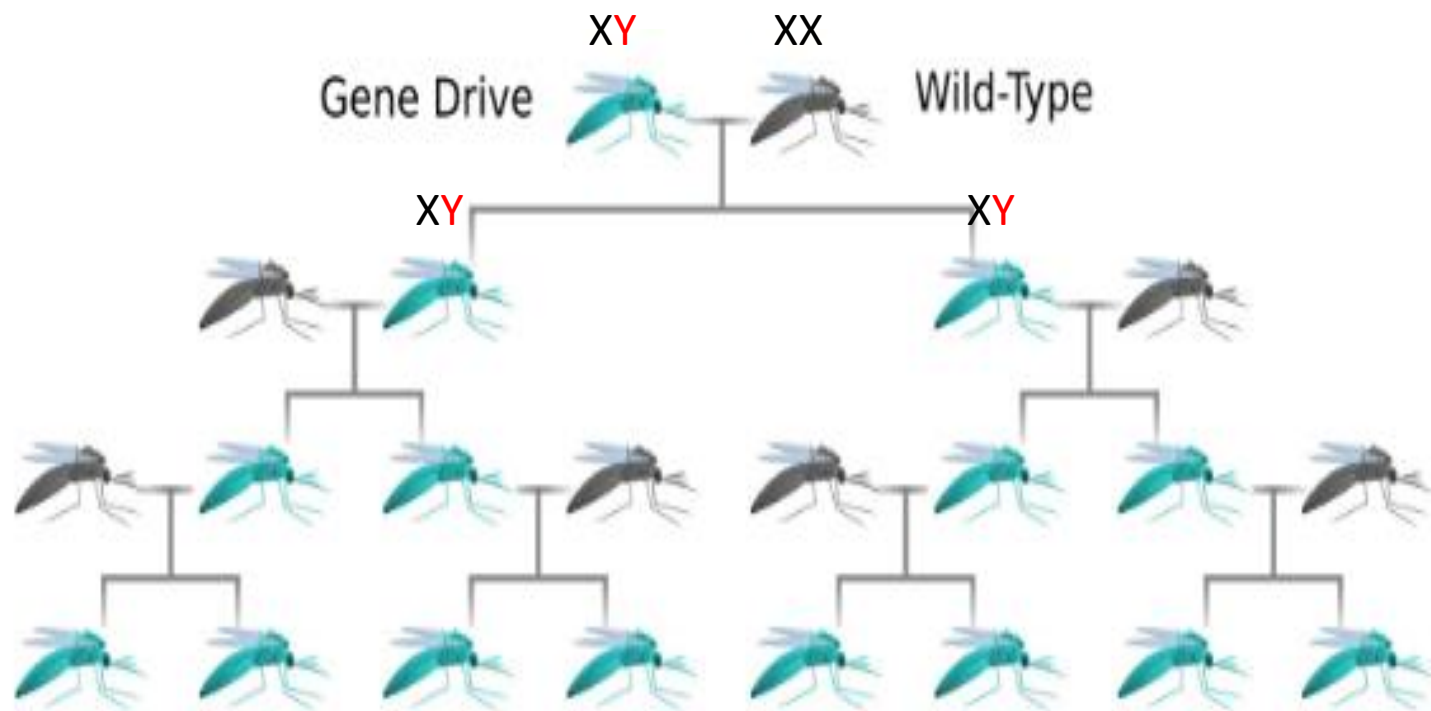
- Causes the biased inheritance of a genetic element in a sexually reproducing organism.
- Larger fraction each generation -> spread of genetic element.
 - "driven into the population".
- This phenomenon occurs in nature too – "selfish genes"
- Applications: disease-transmitting insects, invasive alien species, agricultural pests

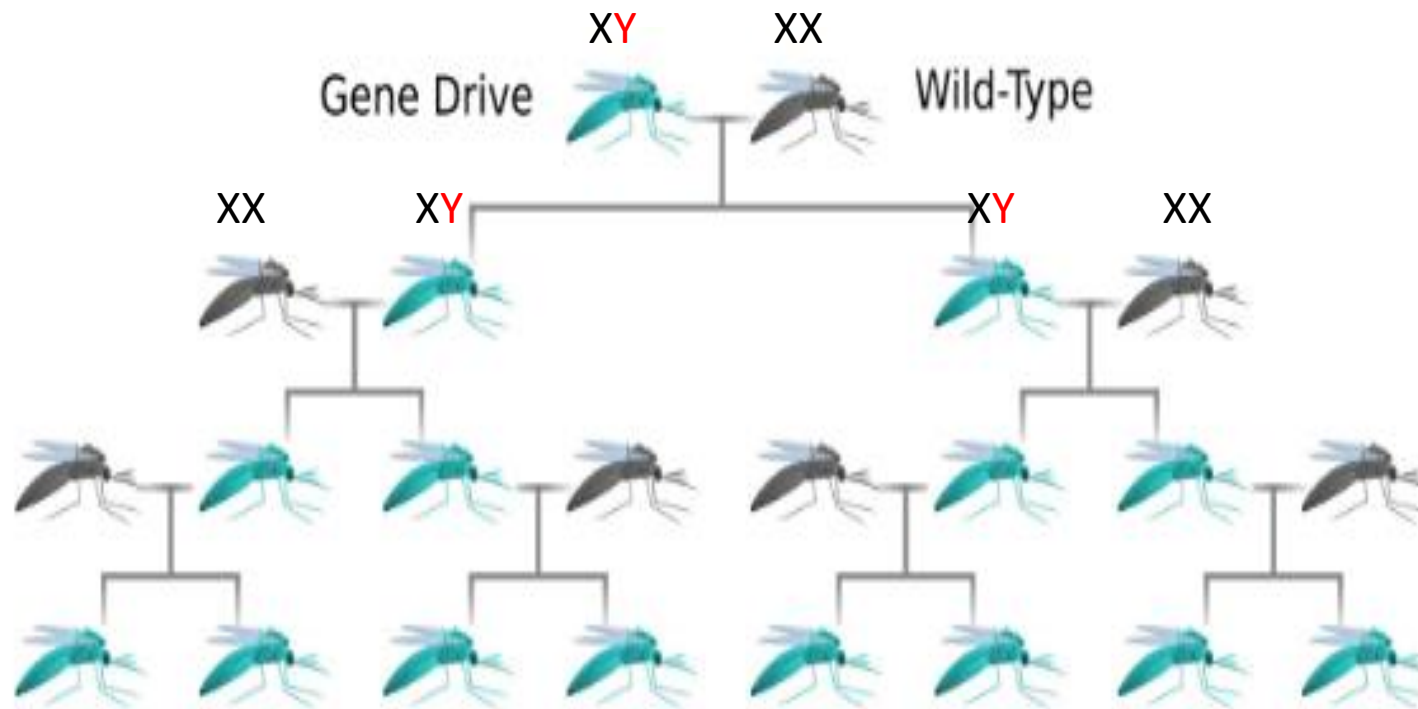
Target Malaria gene drive

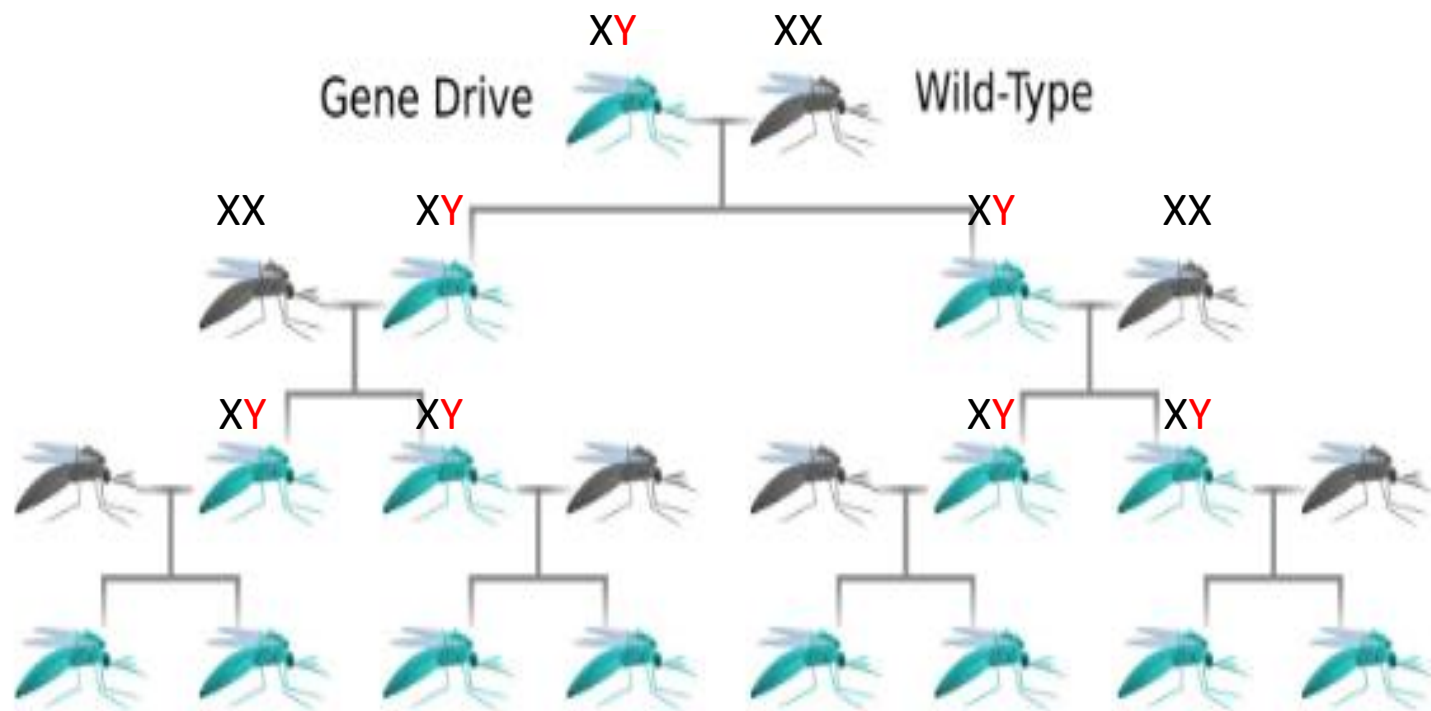
- Target Malaria: *Anopheles gambiae*, *Anopheles coluzzii*, and *Anopheles arabiensis*
- By altering the sex-ratio of mosquito populations
 - XX = female
 - XY = male
- How? The Y-chromosome is engineered to contain an X-cutting gene

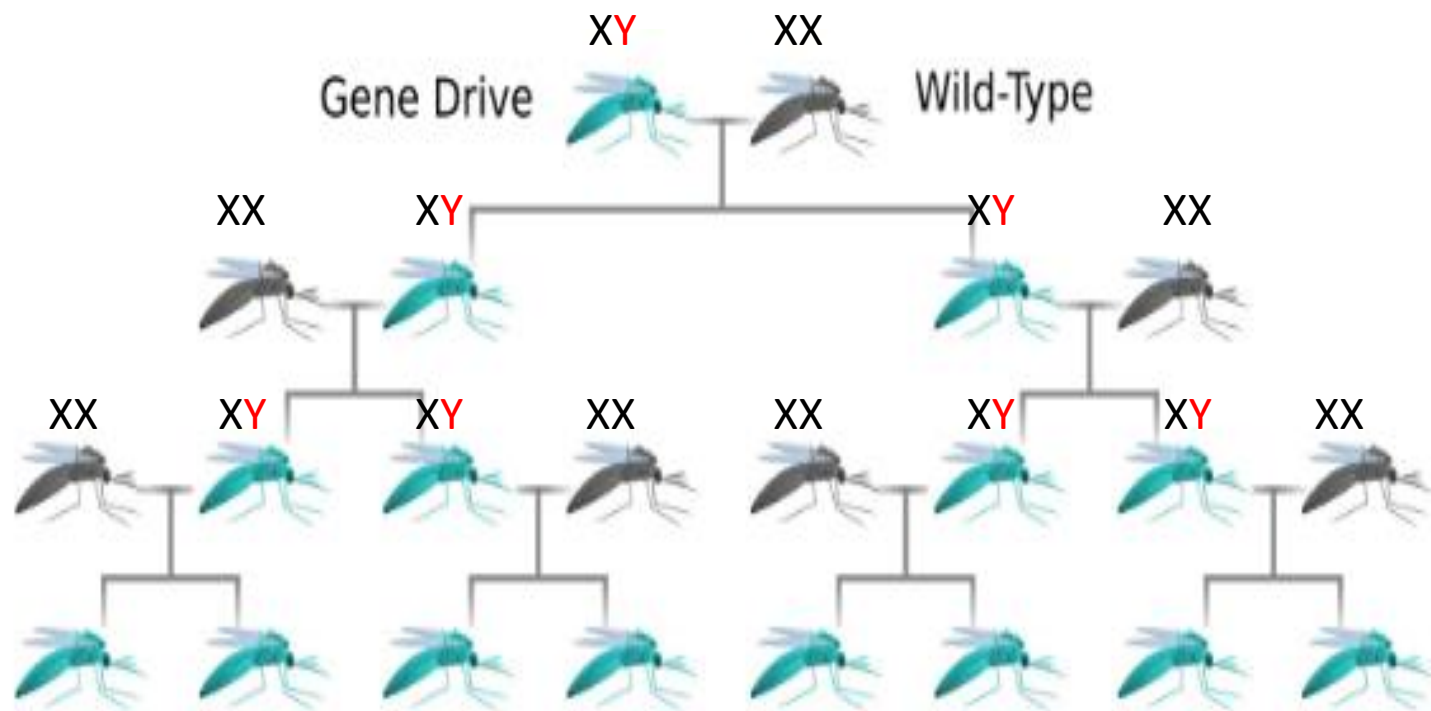


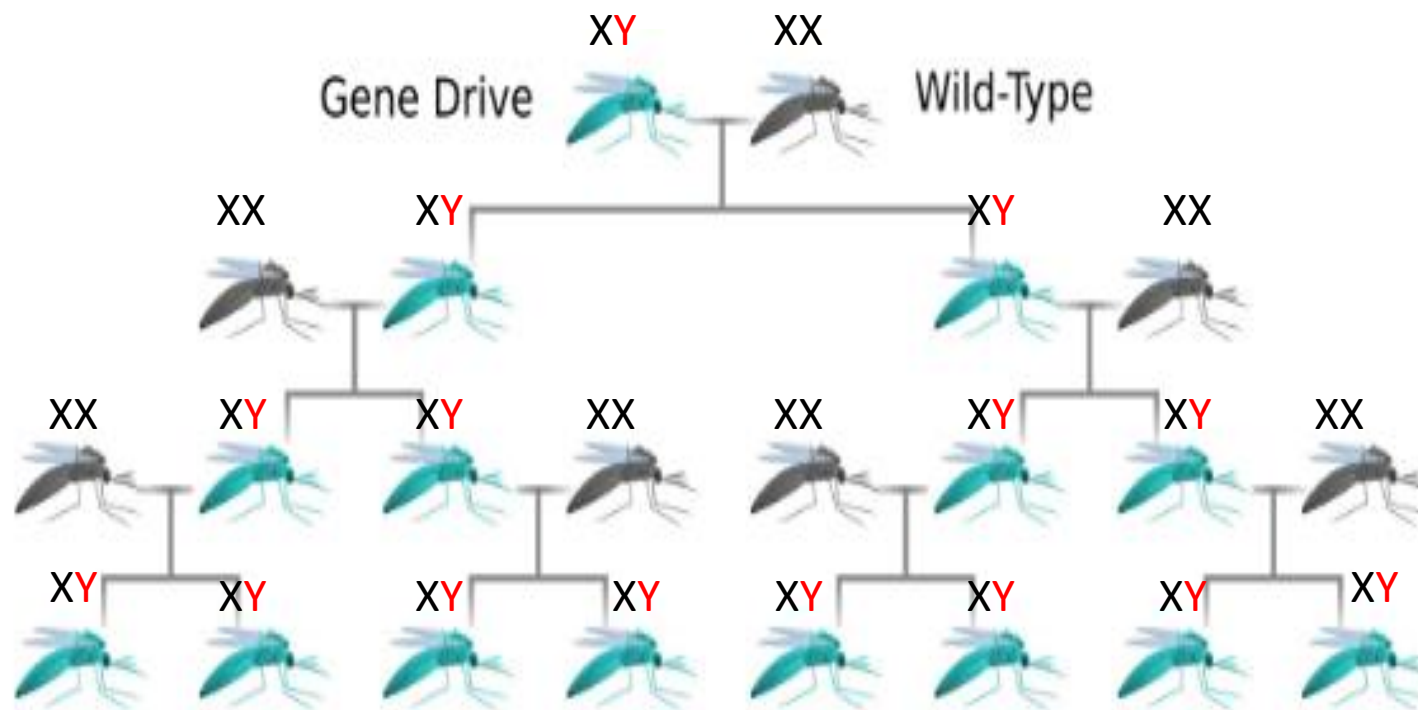


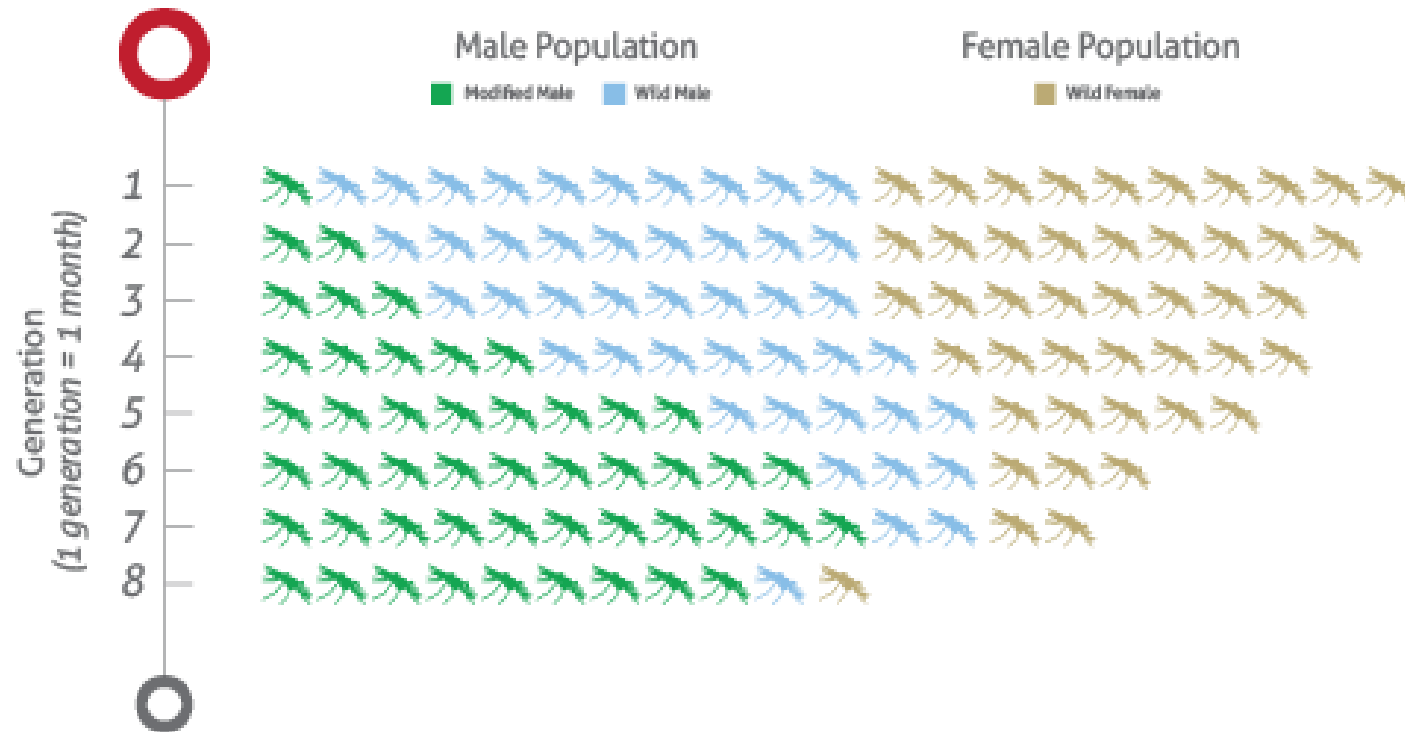












Risks and safeguards

- Potential impact on the wider ecosystem
 - environmental and health effects of insecticide-based mosquito control methods?
 - Little evidence for this in the case of *Anopheles**
- Potential transfer of the gene drive to related mosquito species
 - Mating must be physiologically, anatomically and ecologically possible
- Accidental release from labs
 - Research is performed where mosquitoes are not endemic

- Research into risks is still young, more required – NASEM report**

*Collins, C. M., Bonds, J. A.S., Quinlan, M. M., Mumford, J. D. (2018). Effects of the removal or reduction in density of the malaria mosquito, *Anopheles gambiae* s.l., on interacting predators and competitors in local ecosystems. *Medical and Veterinary Entomology*, (2018), doi: 10.1111/mve.12327

**American Academy of Sciences, Engineering and Medicine: “Gene Drives on the Horizon” (June 2016)

Regulation

- Gene drive organisms fall under GMO regulations
- Several national authorities have reviewed their GMO regulation
- UN Cartagena Protocol on Biosafety to the Convention on Biological Diversity

Thank You