3 Park Place, Suite 307
Annapolis, MD 21401-3722 USA

Phone: 301-731-4535
Fax: 301-731-4538

esa@entsoc.org
www.entsoc.org

ESA Position Statement on the Importance of Continued Innovation in Gene Drive Technology

Approved on September 12, 2019
Valid through September 12, 2023

Innovation is critical for addressing issues facing our modern world. Agriculture relies on selective breeding and biotechnology to counteract insect pests. Challenges presented by insect pests, such as resistance to control products, require development of innovative and pest-specific approaches that fully leverage our understanding of biology. Gene drive technology (GDT) is a relatively new biological control strategy in pest control and conservation following decades of research into naturally occurring gene drive systems. GDT increases the rate of inheritance of genes to ensure a desired trait is passed down to more offspring in a population faster than expected from usual inheritance.[1] Precise molecular tools, such as CRISPR-Cas9, have accelerated the development of GDTs in insects. This rapid development and concerns about unintended ecological impacts of GDT have been met with calls to categorically limit GDT research and development, and proposed moratoriums on GDTs have been twice rejected at the UN Convention on Biological Diversity. Support for the continued development of GDTs recognizes that this technology could have transformative impacts on global food security; human, animal and plant health; and conservation biology.

The Entomological Society of America (ESA), as the largest organization in the world serving the professional and scientific needs of entomologists, recognizes that both pest and beneficial insects are likely candidates for GDTs. ESA recommends that future research should be focused on the following aspects of gene drive technologies:

- **Risk assessment** to evaluate the benefits and risks of applying gene drive technologies in field scenarios, a standard practice for any kind of biological control.
- **Continued basic research** to increase understanding of the biological aspects affected by GDT (e.g., population genetics, ecology, genomics, etc.) to determine insect species that could be susceptible to GDT, if GDT is deemed safe and beneficial.
- **Community engagement** on GDT to foster open dialogue among communities that may benefit from them and to increase our understanding of societal factors underlying implementation.

A potential tool for pest control

GDTs aim to increase the prevalence of a trait in populations faster than the typical rate of inheritance, even if that trait is detrimental to the targeted insect. GDT could theoretically introduce novel traits into entire insect populations, could be used to remove a local population of pest insects or, for example, restore susceptibility to insecticides in resistant insect populations.

These outcomes could be a powerful tool for the control of insect or arthropod disease vectors and agricultural pests; however, GDTs may pose risks that are unique to each design, application, and desired outcome. These risks can range from unexpected impacts on the ecosystem, which may result from controlling an insect pest at the population level for the first time, to technological risks, such as failure of GDTs when insects develop resistance to the gene drive mechanism. It is important that GDT risks and benefits are weighed together at every step of development. GDTs share risks with other insect control technologies, enabling the field to apply lessons learned from the successes and failures of previous area-wide pest control strategies. If gene drive is used in the field for pest control, it is likely it will be incorporated into integrated pest management (IPM) strategies.[2] These strategies monitor pest levels and combine available pest control methods to prevent pests from exceeding an allowable threshold.

Assessment of gene drive technologies through continued research

The risks and benefits of GDTs should be considered with the risks and benefits of continuing current pest control interventions, which may be comparatively less effective or pose exposure risks to human health and the environment. GDTs could integrate with programs aimed to control a variety of insect pests and disease vectors, in collaboration with entomologists. Building on recent reports from the US National Academies of Science, Engineering and Medicine and the International Union for Conservation of Nature, ESA supports research on GDTs to increase our knowledge of their potential uses, benefits, and risks to potentially incorporate GDTs into existing IPM programs.

GDT works at the insect population level, therefore, a high level of control over GDT area of spread and time of influence is necessary for possible incorporation into IPM programs, which require iterative monitoring and adjustment of interventions to ensure targeted insect populations are held below allowable thresholds. To control gene drive spread and the timing of the GDT's influence on the targeted insect population, various strategies are being explored such as designing reversal drives or using a gene drive that stops functioning after a determined time (*e.g.*, daisy chain drive[3]). Although a variety of these strategies exist, none have been shown to work sufficiently to test outside of laboratory experiments, which is an existing barrier to field testing of GDTs.

Successful development of GDTs, which relies on mating and passing on traits to the next generation to function, requires a candidate with rapid reproduction, the ability to be reared in high numbers and for which molecular tools are available to efficiently and precisely alter the organism. Insect pests are particularly promising GDT targets, and it is likely entomologists will continue to play an important role if GDTs are used for pest control. As such, entomologists will be instrumental in generating data to support ecological risk assessment of GDTs.

Community engagement and interdisciplinary collaboration

To inform development and assessment of GDTs, we will need detailed entomological data on the targeted insect population to acquire sufficient field-relevant data. This will require requisite investment of time and money in entomological research and collaboration of entomologists with risk assessment professionals, a field unto itself. Since GDTs act on an insect population, few applications of gene drive will fit neatly into a single community or jurisdiction: this may present issues when insect populations span areas where community acceptance or regulatory approval of GDTs are in conflict.

No pest management intervention can reach its full potential without community acceptance, and GDTs are no exception. The burgeoning GDT field offers entomologists the opportunity to engage in dialogue with stakeholders (e.g., politicians, regulators, and community members) that may benefit from this technology. These stakeholders, scientists included, will each bring their own values and concerns regarding gene drive development. It is the responsibility of scientists to ensure communities are consulted by trained professionals (i.e., social scientists) about GDTs for specific applications. Community engagement early and often should make GDT development a team effort between natural and social scientists working together with local communities.[4] Defining these communities for a given technology and addressing and including their concerns in the development of GDTs is no small task, but these pursuits are as essential as biological research. Achieving this goal will require collaborations among researchers across many fields and disciplines.

GDTs likely offer solutions to problems that threaten the health of our societies and our global ecosystem. For now, much of that power is theoretical, and these technologies are only used in laboratory settings. Entomologists will continue to play an important role in the development of GDTs, and their research will serve to strengthen our ability to assess ecological risks presented by each GDT. As these technologies advance, public awareness and scrutiny of gene drives will also increase. If the benefits of using GDTs outweigh their risks, partnerships between entomologists and social scientists will be crucial from the development to the implementation of GDTs.

ESA is the largest organization in the world serving the professional and scientific needs of entomologists and people in related disciplines. ESA today has over 7,000 members affiliated with educational institutions, health agencies, private industry, and government. Headquartered in Annapolis, Maryland, the Society stands ready as a non-partisan scientific and educational resource for all insect-related topics. For more information, visit www.entsoc.org.

---

1 **ESA Fact Sheets.** Annapolis (MD): Entomological Society of America. 2017. [accessed 2019 Sept 03]. https://www.entsoc.org/sites/default/files/files/Science-Policy/ESA-FactSheet-Gene-Drive.pdf.
2 **ESA Fact Sheets.** Annapolis (MD): Entomological Society of America. 2017. https://www.entsoc.org/sites/default/files/files/Science-Policy/ESA-Factsheet-IPM.pdf.
3 **Marshall JM, Akbari OS. 2018.** Can CRISPR-based gene drive be confined in the wild? A question for molecular and population biology. ACS Chem. Biol. 13(2):424-30.
4 **James S, Collins FH, Welkhoff PA, Emerson C, Godfray HC, Gottlieb M, Greenwood B, Lindsay SW, Mbogo CM, Okumu FO, Quemada H.** 2018. Pathway to deployment of gene drive mosquitoes as a potential biocontrol tool for elimination of malaria in sub-Saharan Africa: recommendations of a scientific working group. Am. J. Trop. Med. Hyg. 98:1-49.