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Using CRISPR-based gene drive for agriculture pest control

Virginie Courtier-Orgogozo[1], Baptiste Morizot[2] & Christophe Boëte[3]

Reply to: **SL Young** (in this issue) and **N Gutzmann *et al*** (in this issue)

Stephen Young describes an alternative or complementary emerging strategy for controlling pests in agriculture: the use of artificial intelligence and robotic machines to physically destroy individual pests [1]. He emphasizes that, while genetics focuses on internal modifications of pests, such technological approaches rely on external manipulation. Robotic technology seems an attractive approach to eliminate pests given that it should have fewer long-term effects on the environment compared to pesticides or CRISPR-based gene drive (GD). We note, however, that robots might have a hard time dealing with rugged landscapes, small insects, burrowed eggs, or flying pests. The range of pest species that could potentially be targeted with GD is larger than with robots.

Gutzmann *et al* [2] argue that GD will face greater technical and governance challenges than suggested by our article. We agree with their points, although we did not develop these limitations in our paper. Indeed, GD is still technologically challenging and requires biological knowledge about the targeted species. Whether GD will be as effective in plants and vertebrates as it is observed in insects remains unknown. The problem of GD resistance is also real and acute at both the theoretical [3] and experimental [4] levels. Recent work suggests, however, that resistance might be overcome using multiplexed guide RNAs [5 and references therein]. Our paper is alerting on a technology that is clearly not yet applicable, but close.

The authors list various examples of public forums and workshops on GD ethics and governance. They appreciate that the glass of discussions is half full while we worry that it is half empty. Most discussions so far have been initiated by biologists, who are not unbiased in this dialogue, and no scientific or ethical consensus has emerged yet. The recent controversy and secrecy surrounding field trials with transgenic mosquitoes—carrying no gene drive—by Oxitec, despite calls for regulation oversight, demonstrate the lack of agreement and regulation [6,7]. The US National Academies of Science, Engineering, and Medicine might not have "approved" research on GD but they explicitly wrote that "the potential benefits of GD [...] justify proceeding with [...] highly-controlled field trials", which, to us, is already a big step forward [8].

Gutzmann *et al* also question the interests of large agro-biotech companies in using GD to control pests because this would yield little economical benefit. Unlike the coupling of resistant GMOs and specific pesticides commercialized by the same company, GD would indeed reduce the profits generated by the sale of pesticides. This argument is valid, but the question remains a matter of scale and actors. Any business or economic player who is experiencing a decline in agricultural yield owing to local pests that do not affect their competitors' production—and who operates on an economic model in which short-term yield is more important than long-term sustainability—is likely to seize GD as a technique that matches its objectives. This is what we call the structural compatibility between GD and extractivism.

It therefore is important to raise issues associated with the use of GD for agricultural pest control as we did in our paper. We join Gutzmann *et al* in wishing that all actors engage fully and honestly with each other to shape the future of GD and its potential applications for agricultural pest control.

References

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1 CNRS, Institut Jacques Monod, Université Paris Diderot, Paris, France. E-mail: virginie.courtier@ijm.fr
2 Ceperc, UMR 7304, Aix-en-Provence Cedex 1, France
3 ISEM, UMR544, CNRS-UM-IRD-EPHE, Université de Montpellier, Montpellier cedex 5, France
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