Case study: Reducing the risk of vector-borne diseases

The global challenge

Vectors are animals, like mosquitoes, that carry disease-causing pathogens from one person to another. Vector-borne diseases are carried by these organisms and include malaria, dengue, Zika and Lyme disease. There are around one billion cases of vector-borne diseases worldwide each year, resulting in more than a million deaths. Malaria, dengue and Zika are carried by mosquitoes, while Lyme disease is carried by ticks.

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Approaches to disease vector control

Common approaches to reducing the risk of a vector-borne disease are using pesticides to kill the vector and preventing vectors from biting people by encouraging vulnerable people to sleep under bed nets, covering their skin with clothing and wearing insect repellent. For short time-periods, people can take preventative medicines for some diseases, including malaria. Vaccines for malaria and dengue are in advanced stages of testing but are only partially effective. Malaria and Lyme disease can be treated if they are caught quickly enough, but there is no specific treatment for dengue.

A genetic technologies example

An Oxford-based biotechnology company has genetically engineered mosquitoes to produce offspring that cannot reproduce. Mosquito eggs were genetically engineered, by injection in the lab, to contain a fatal gene. Male mosquitoes born from these eggs are kept alive using an antidote while females are killed. These males are then released into the wild to mate with wild females before dying. The offspring of the wild females that had mated with the engineered males inherit the fatal gene, which means they die within a couple of weeks, before they can breed. This should reduce the target mosquito population. Because both the engineered mosquitoes and their offspring die, the effect of these interventions reduces over time and they need to be repeated regularly to maintain their effectiveness.

Scientists are also working on genetic interventions to reduce the population of disease-carrying mosquitoes using ‘gene drives’, which could deliver long-lasting population reductions.

UK facts & figures

- The UK is home to 34 native mosquito species, none of which carries malaria or dengue
- However, there are more than 20 species of tick in the UK, several of which carry Lyme disease
- In the UK, around 3,000 people every year contract Lyme disease from ticks.

Arguments in favour of genetic engineering approaches to disease vector control

- The continuing burden of disease and death toll from diseases such as dengue, malaria, Zika and Lyme disease demonstrate that existing interventions are not completely effective. Genetic approaches offer the possibility of a new class of interventions to add to existing ones
- The costs of current prevention methods are too high to be used effectively in some countries, whilst the cost of current treatments are unaffordable to some people. Genetic approaches may alleviate this pressure on health systems by reducing the costs of prevention and the costs of treatment
- In the case of mosquito-borne diseases, the mosquito populations are evolving resistance to the existing chemical methods of control. Genetic approaches could prevent some of these resistant mosquitoes from reproducing and so prolong the usefulness of current methods
- Where genetic approaches are used instead of chemical methods of control, negative impacts on plants and other animals from using these insecticides could be reduced.

Arguments against genetic engineering approaches to disease vector control

- The consequences for local ecosystems of introducing genetically engineered disease vectors to the environment could be difficult to predict and control, and some effects could be irreversible
- How effective genetic engineering interventions can be is still the subject of research, and disease vectors might also develop resistance to them
- The accidental release or escape of animals involved in gene drive research could have permanent unintended consequences
- The improved technological understanding gained from developing gene drives for vector control purposes could make it easier to develop gene drives for illegal or unregulated purposes, although this would depend on developing new gene drives as it’s not possible to use the same drive in different species.