21. **Can we prevent pathogen adaptation when breeding livestock for resistance to infectious diseases?**

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Recent research shows that genetic selection has high potential to reduce the prevalence of infectious diseases in livestock. However, like all interventions targeted at infectious diseases, genetic selection of livestock will exert selection pressure on pathogen populations. This selection pressure leads to the evolution of escape strategies which reduce the effect of selection of livestock for disease resistance. Thus, to sustainably reduce the prevalence of infectious diseases through breeding, selection strategies that prevent the invasion of these escape mutants are needed. We use a mathematical model of infection transmission that accounts for genetic selection in the host and pathogen to investigate the conditions under which escape mutants of the wild-type pathogen can invade in a closed livestock population. The results show that genetic selection for resistance typically leads to an 'invasion window', the range in frequency of resistant hosts in which an escape mutant can invade. This window is smallest when host resistance is strong. To minimise opportunities for pathogens to adapt, the aim of disease control through genetic selection should be to achieve herd-level eradication of the infection faster than the rate of emergence of escape mutants of the pathogen. This could be achieved by placing animals into herds according to their genetic resistance, such that herds stay completely out of the invasion window. Our model further suggests that the common approach in animal breeding, multi-trait selection, is not a sustainable strategy when resistance to infectious disease is part of the breeding goal.

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