

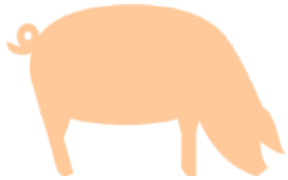
Indirect effects in infection transmission enhance genetic selection and other interventions

Dries Hulst, Piter Bijma, Mart de Jong
EAAP 2023, Lyon

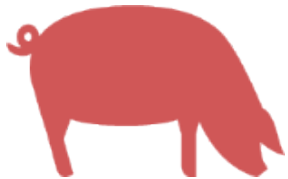


Genetic selection as intervention against infectious disease

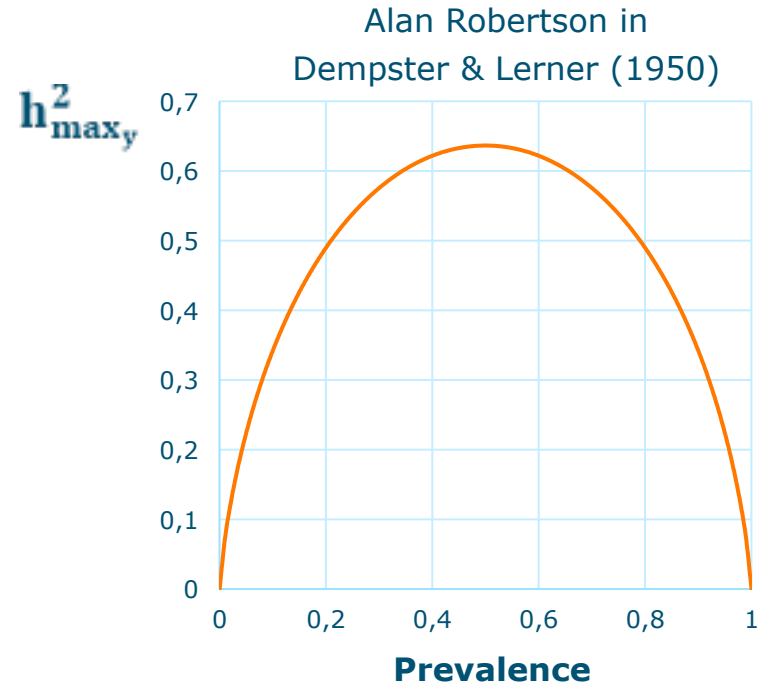
Trait



Non-infected $\longrightarrow y=0$

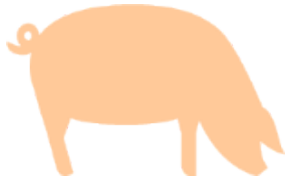


Infected $\longrightarrow y=1$

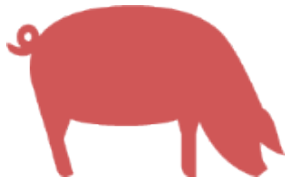


Genetic selection as intervention against infectious disease

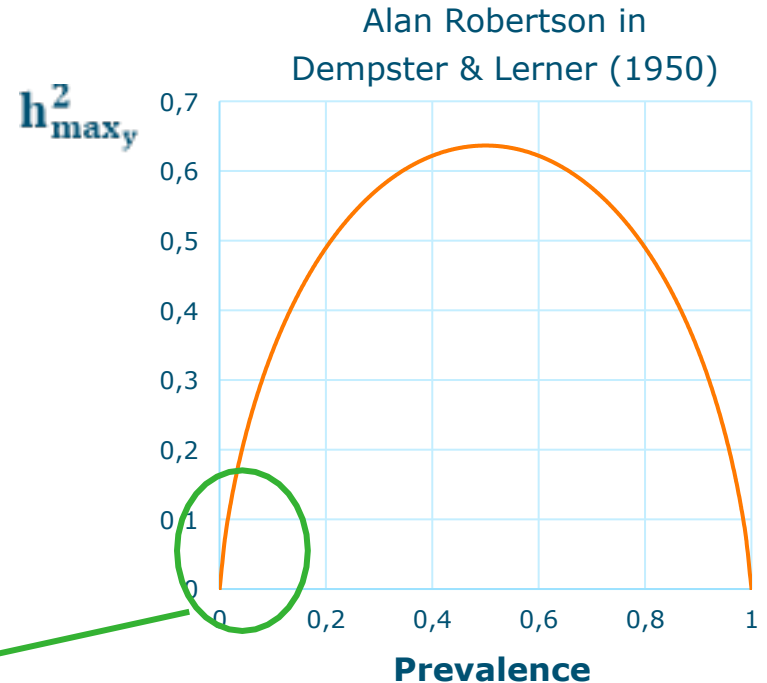
Trait



Non-infected $\longrightarrow y=0$



Infected $\longrightarrow y=1$



Eradication seems impossible!

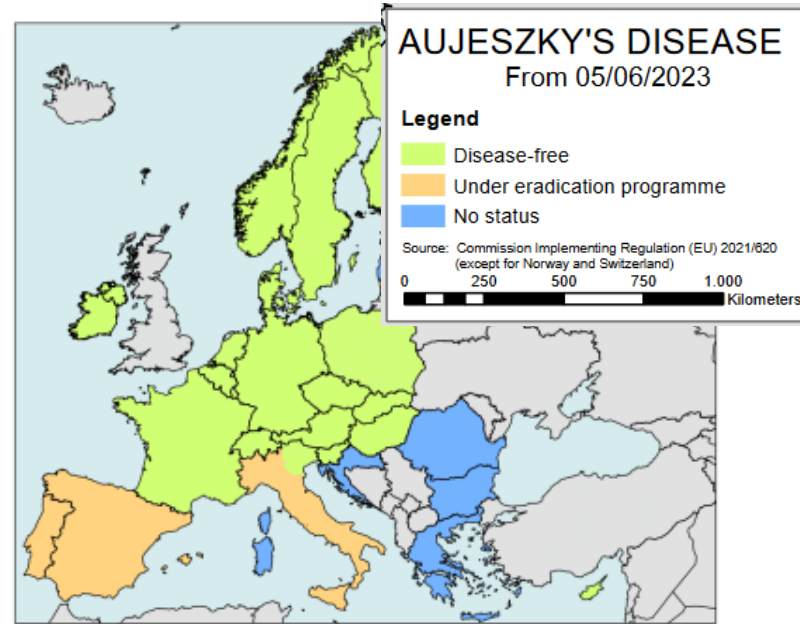
Eradication is certainly possible

Scientists eradicate deadly rinderpest virus

Elimination of virus that causes deadly cattle plague makes rinderpest only the second viral disease in history to have been wiped out by humans



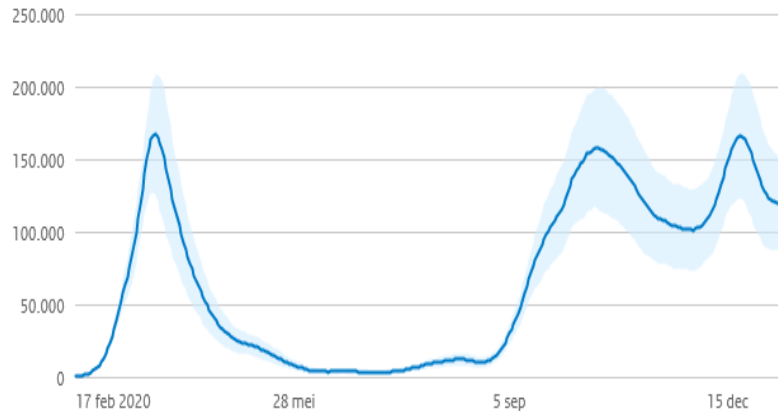
WHO commemorates the 40th anniversary of smallpox eradication



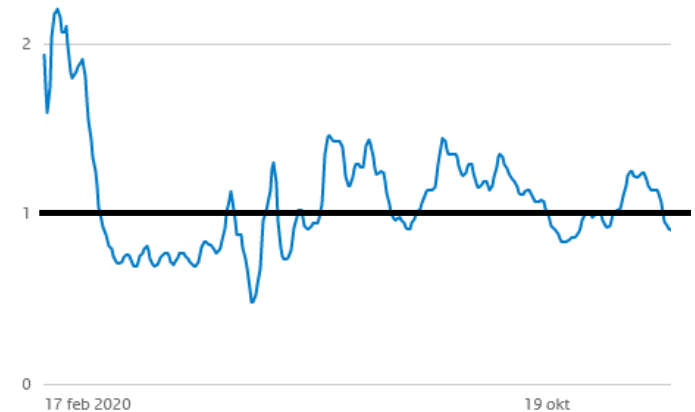
WHO: Afghanistan, Pakistan Close to Eradicating Polio

Transmission dynamics of infectious diseases

Covid19 infections in NL



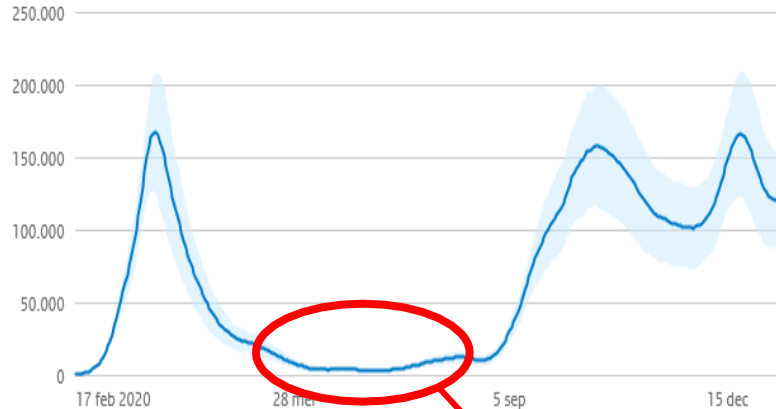
Reproduction number



Source: RIVM

Transmission dynamics of infectious diseases

Covid19 infections in NL



Reproduction number



Opportunity for local eradication

Source: RIVM

Transmission leads to indirect effects

Starting prevalence: 0.25

Selection differential: **-0.01**

In the **current population** we expect a prevalence of 0.24 for the selected animals

Transmission leads to indirect effects

Starting prevalence: 0.25

Selection differential: **-0.01**

If we breed a full new population, we get:

$$-0.01 * \frac{1}{0.25} = \mathbf{-0.04}$$

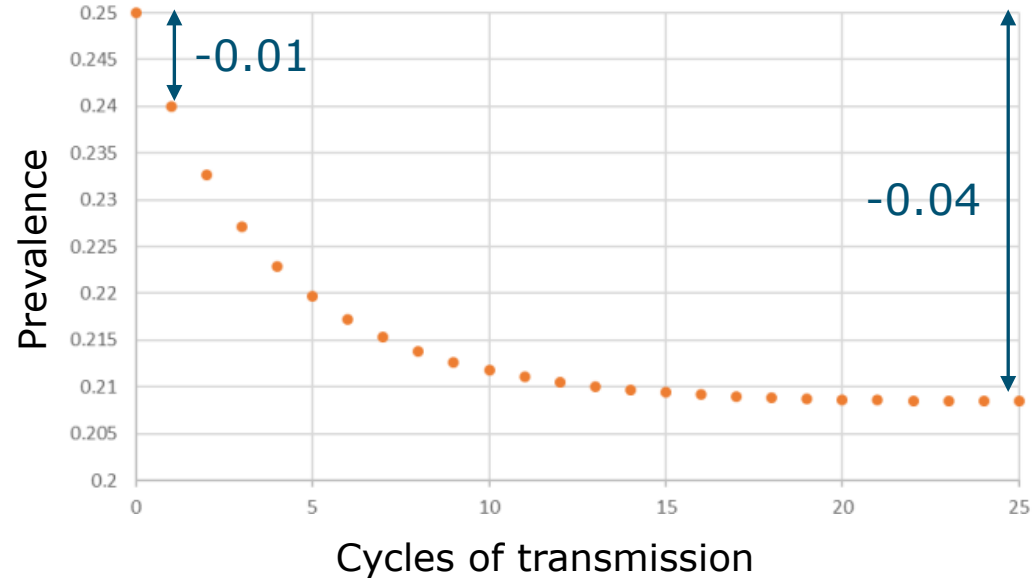
Transmission leads to indirect effects

Starting prevalence: 0.25

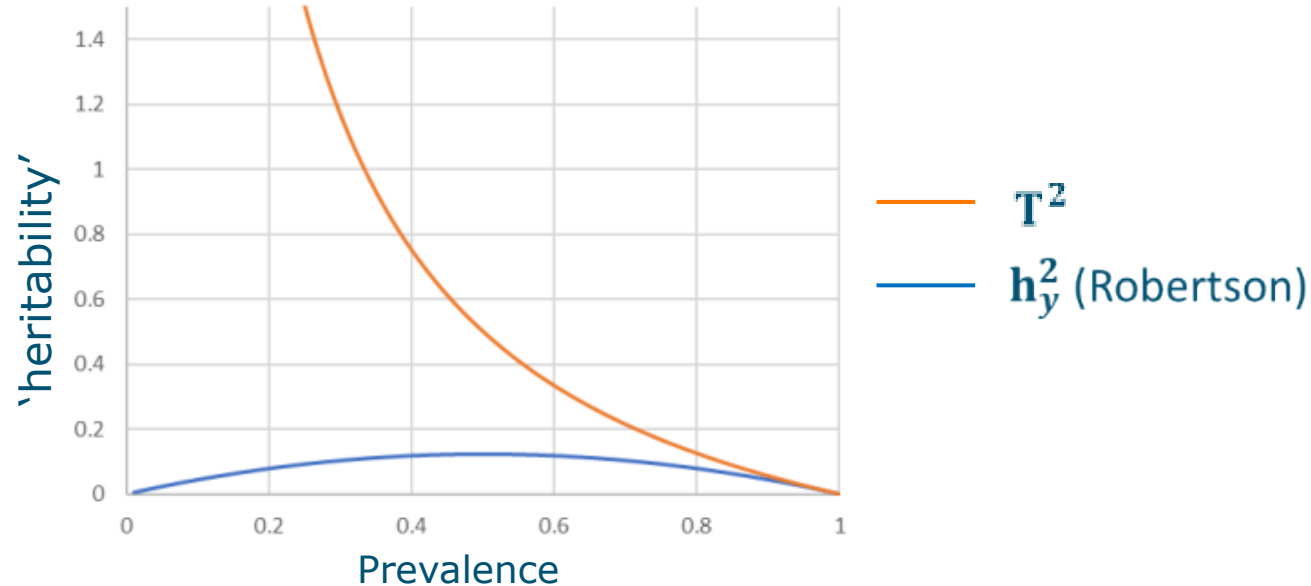
Selection differential: **-0.01**

If we breed a full new population, we get:

$$-0.01 * \frac{1}{0.25} = \mathbf{-0.04}$$



The size of the indirect genetic effects depends on prevalence

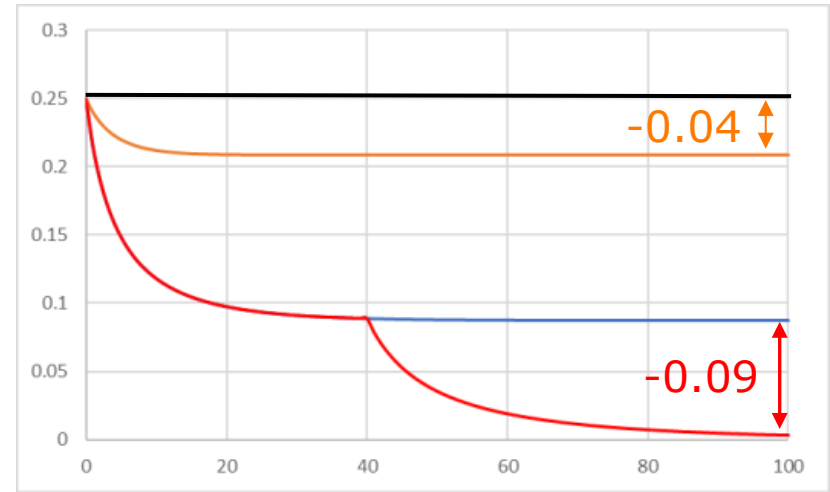
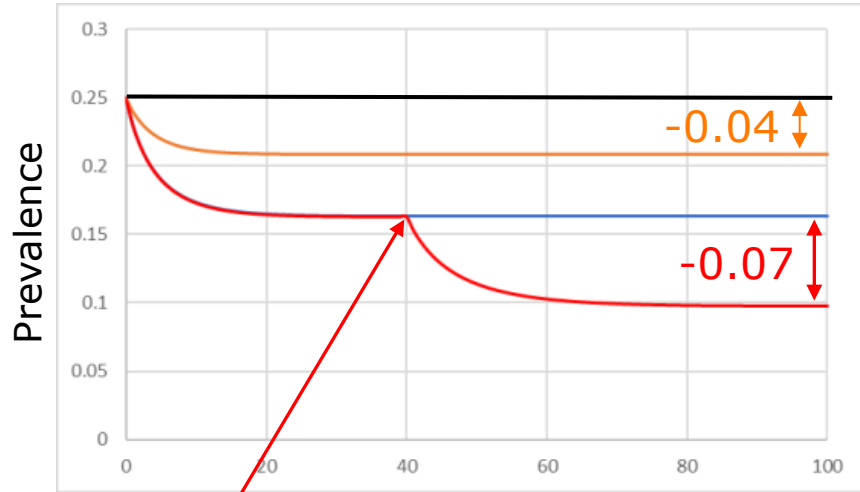


Heritable variation increases strongly with decreasing prevalence

How can we use other interventions to improve selection?

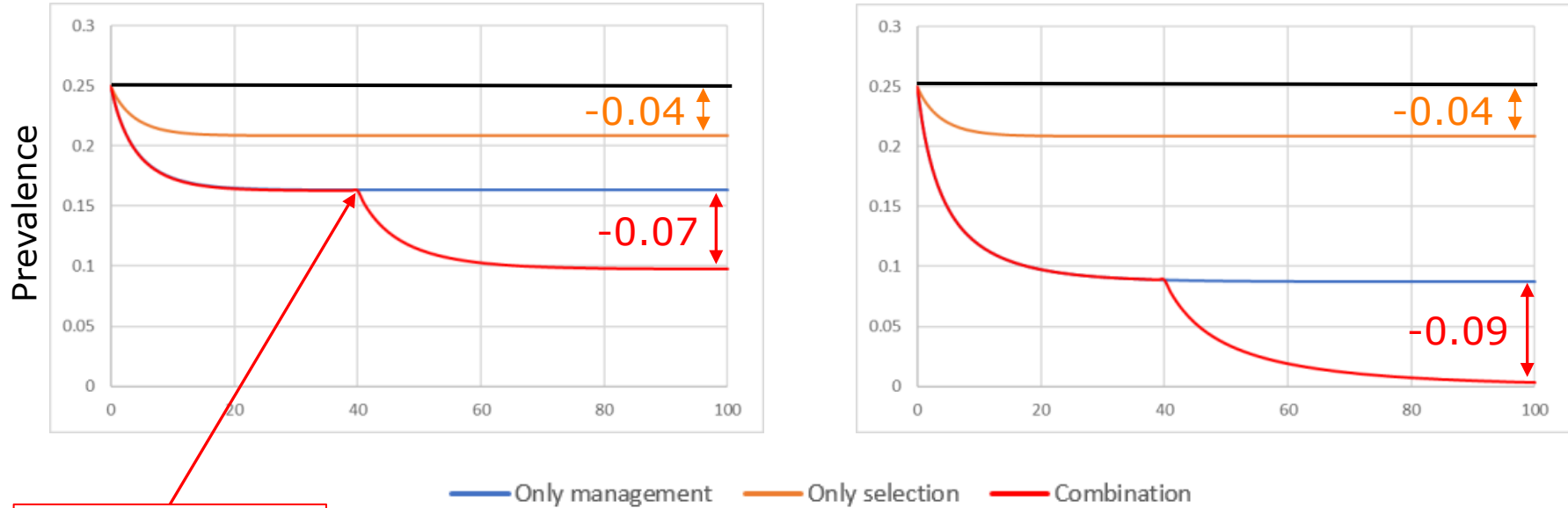
- Will other interventions that reduce prevalence increase the effect of selection?
- Is local eradication feasible?

Other interventions amplify selection



— Only management — Only selection — Combination

Other interventions amplify selection



The effect of selection doubles when combined with an other intervention!

Implications/Conclusion

Genetic selection can play an important role in eradication of infections:

- Aim for **herd-level** eradication
- Use the **indirect effect** (sorting)
- **Combine** with other interventions
- Prevent breeding of **resistance-resistant pathogens**