APPLYING MATHEMATICS TO SUPPORT TUBERCULOSIS MANAGEMENT

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VACCINATING AGAINST TUBERCULOSIS (TB) IN SPANISH WILD BOAR

- In Central Spain wild boar share water holes with cattle and other wild species.
- Wild boar are the key reservoir of TB infection and suffer very high prevalence of disease.
- Infected wild boar shed free-living infected particles risking transmission of infection to animals which co-habit their environment.

VACCINATION TRIALS

- A pioneering vaccine to protect wild boar from TB is being trialled.
- Young wild boar are more prone to infection than adults.
- Piglets aged 3-6 months are targeted. Vaccinated Piglets maintain immunity until adulthood.
- The field results showed a modest reduction in TB prevalence but the infection remained endemic in the wild boar population.

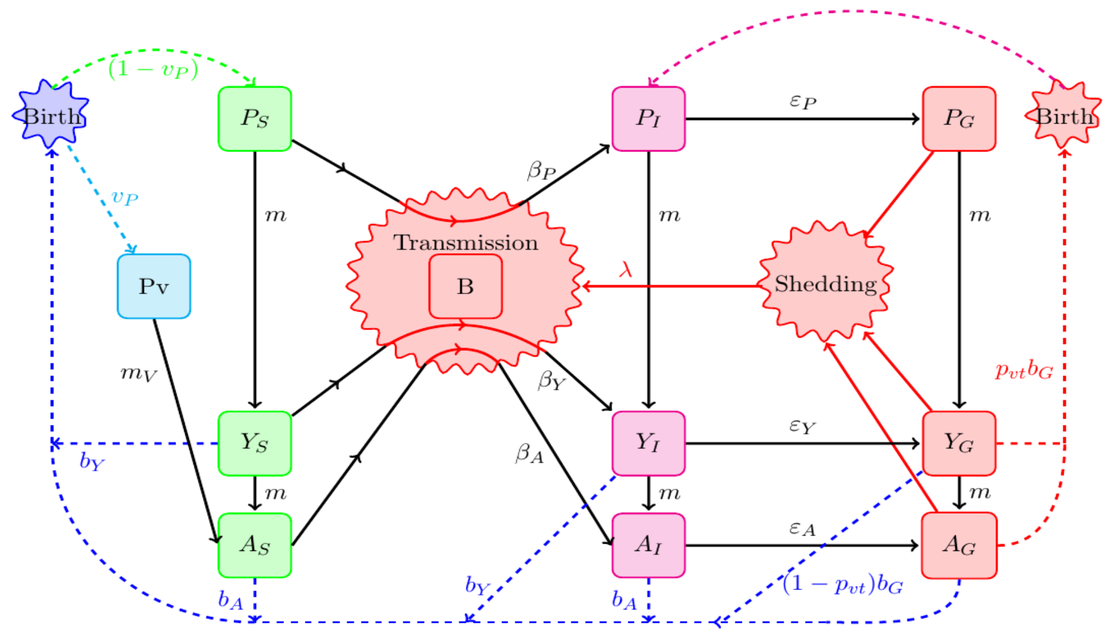
WHAT ROLE CAN MATHEMATICS PLAY?

- Vaccination field trials are expensive and can only offer short-term insight.
- Mathematical modelling can help to fully understand the underlying infection processes.
- Mathematical models can inform about the long-term implications of vaccination and management practices.

Key Wild Boar TB Vaccination Model Attributes

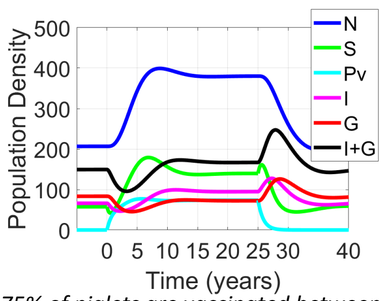
- The model considers a wild boar population (N) composed of: Piglets (P) 0-1 years; Yearlings (Y) 1-2 years; and Adults (A).
- Yearlings and Adults can give birth.
- Infection occurs by contact of a susceptible wild boar (S) with free-living infected particles (B).
- A proportion of new-born Piglets are infected before vaccination can occur.
- Piglets and Yearlings are more at risk of infection than Adults.
- Vaccinated Piglets (Pv) lose immunity when they reach adulthood.
- Infected wild boar (I) become generalised (G) when they shed infected particles.
- Generalised wild boar suffer high levels of disease-induced mortality.

Schematic of the wild boar TB vaccination model

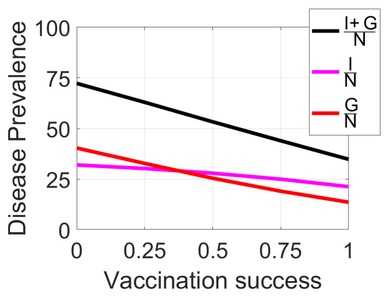


Wild boar age from top to bottom. Infection progresses left to right. Infection occurs through environmental transmission.

Model Results



75% of piglets are vaccinated between years 0-25.



Reduction in disease prevalence for different vaccination levels

- Initially vaccination leads to a substantial reduction in infected wild boar.
- Reduced levels of infection means less disease-induced death and so the total population size increases.
- Increased total population size can support increased levels of infected.
- Long-term vaccination reduces prevalence but does not reduce the density of infected wild boar or the release of infected particles.
- Increased vaccination success reduces disease prevalence but does not eradicate the disease.

Key Conclusions

- Vaccination of piglets reduces TB prevalence in the wild boar population.
- BUT decreased prevalence is driven by greater numbers of healthy rather than reduced numbers of infected wild boar.
- As vaccination does not reduce the density of infected wild boar it does not reduce the risk of environmental transmission to other species.
- Infection levels may increase once vaccination is stopped.
- **UK implications**: wild boar are increasing in the UK where wildlife reservoirs of TB already exist. Wild boar may become a significant TB reservoir host. Our results show that mathematical modelling is essential to understand the consequences of disease management strategies.

MIGSAA

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