

# Open session of the Standing Technical and Research Committees of the EuFMD

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## Mass vaccination, immunity and coverage:

## Modelling population protection against foot-and-mouth disease in Turkish cattle

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## Mass vaccination

FMD vaccine protection:

- **Requires several doses ( $\geq 3PD_{50}$ )**
- **Declines with time since vaccination**

### Mass vaccination

Population immunity  $\approx$  Population vaccination history  
[No. of doses, time since last dose]

Population vaccine history  $\approx$  Population age structure

# Mass vaccination twice a year:

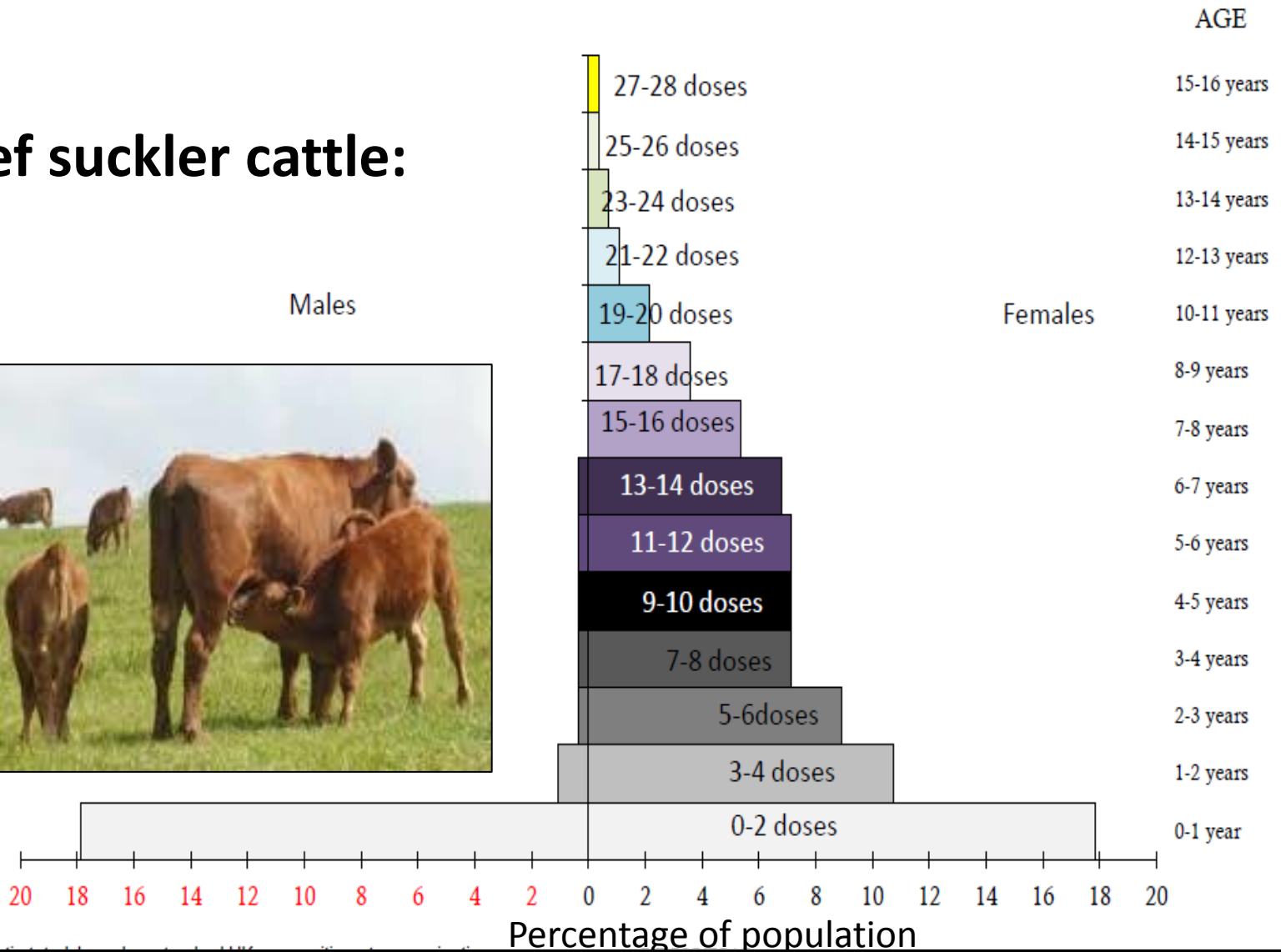
## Population age-sex-vaccination distribution

### Beef suckler cattle:



Males

Females



# Mass vaccination twice a year:

## Population age-sex-vaccination distribution

### Beef fattener cattle:



**Different production system = different age structure = different population immunity**

Males



Females

Age

4-5 years

3-4 years

2-3 years

1-2 years

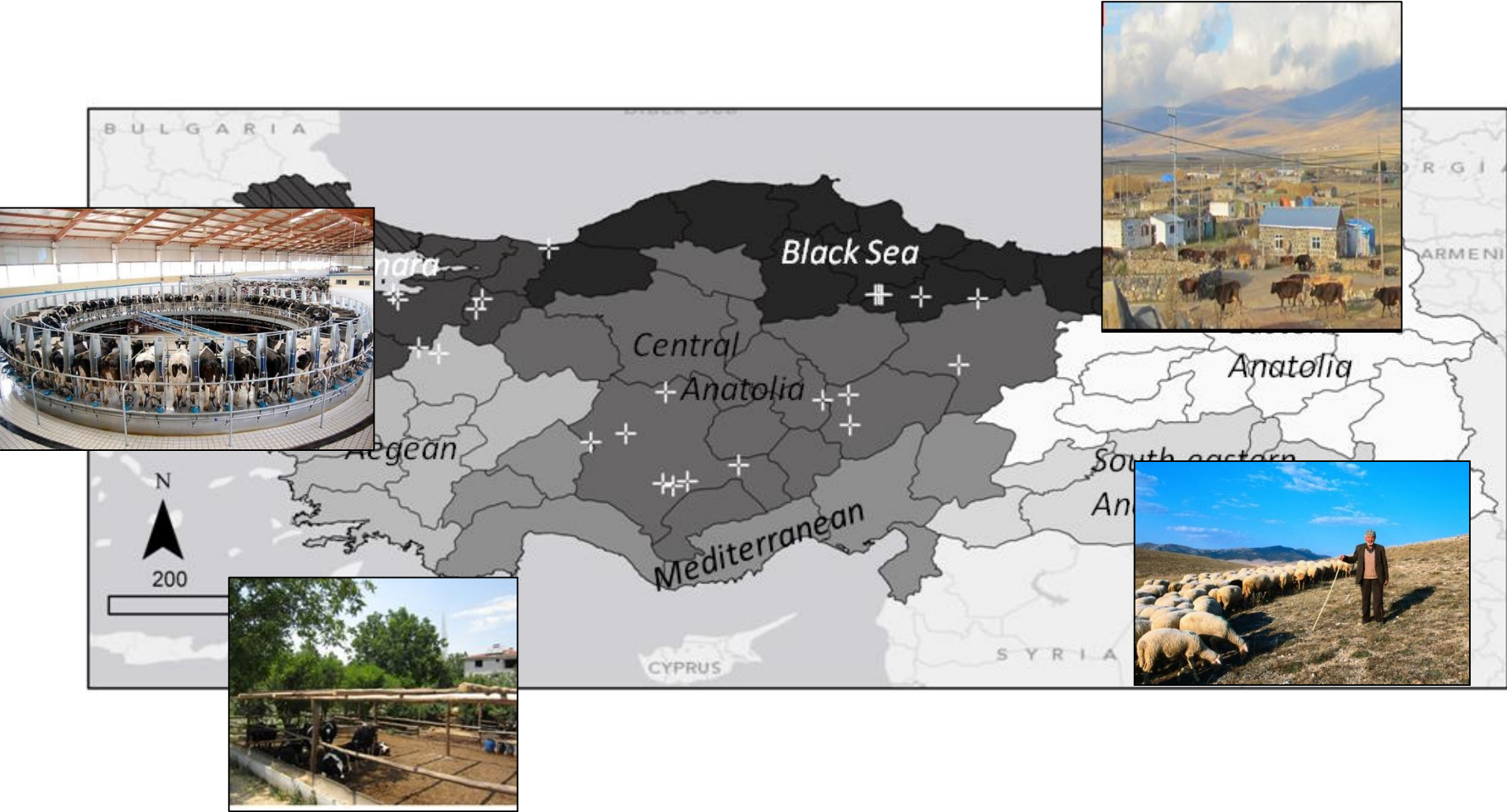
0-1 years

7-8 doses

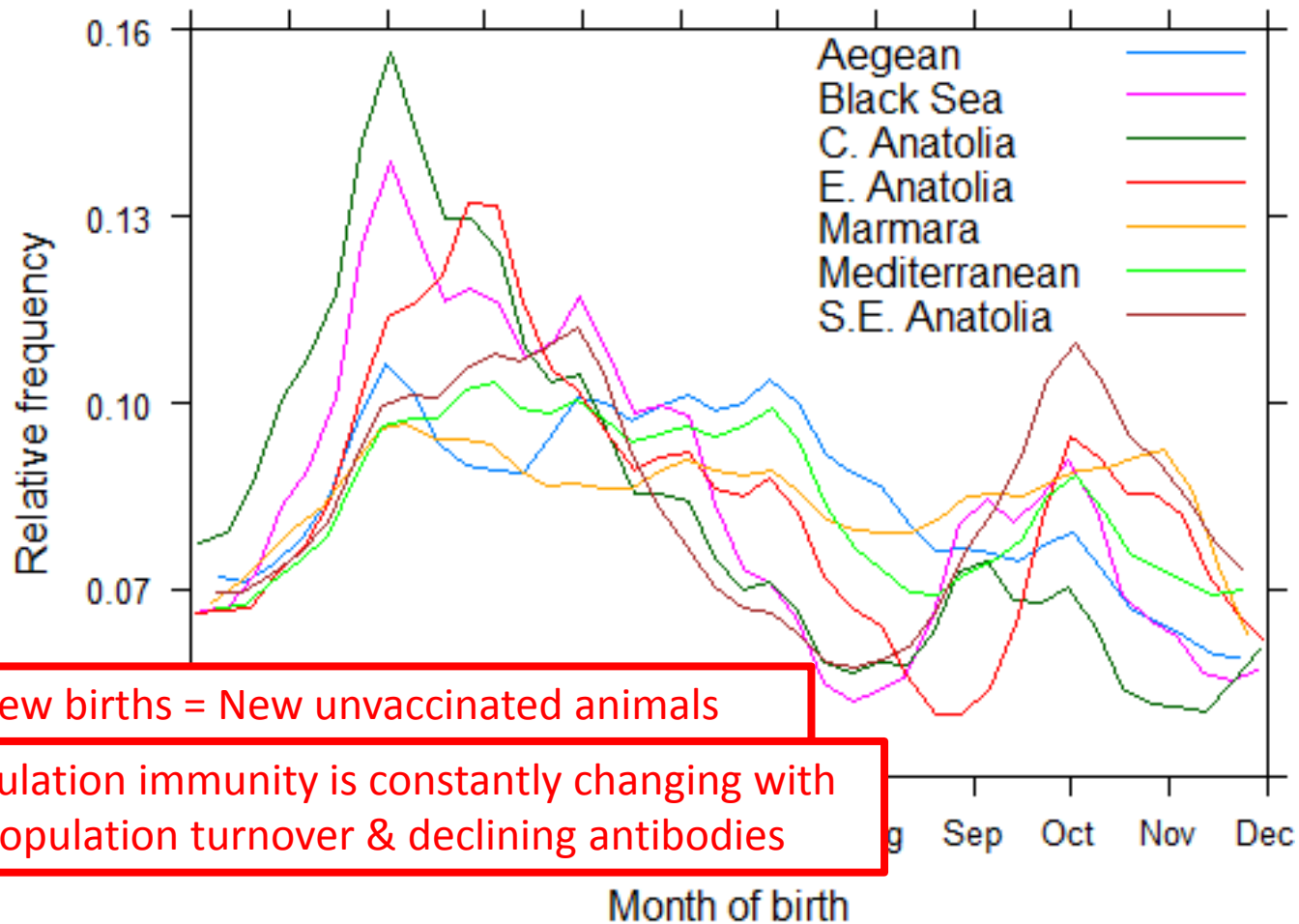
5-6 doses

Percentage of population

# Population vaccine history & immunity varies by region



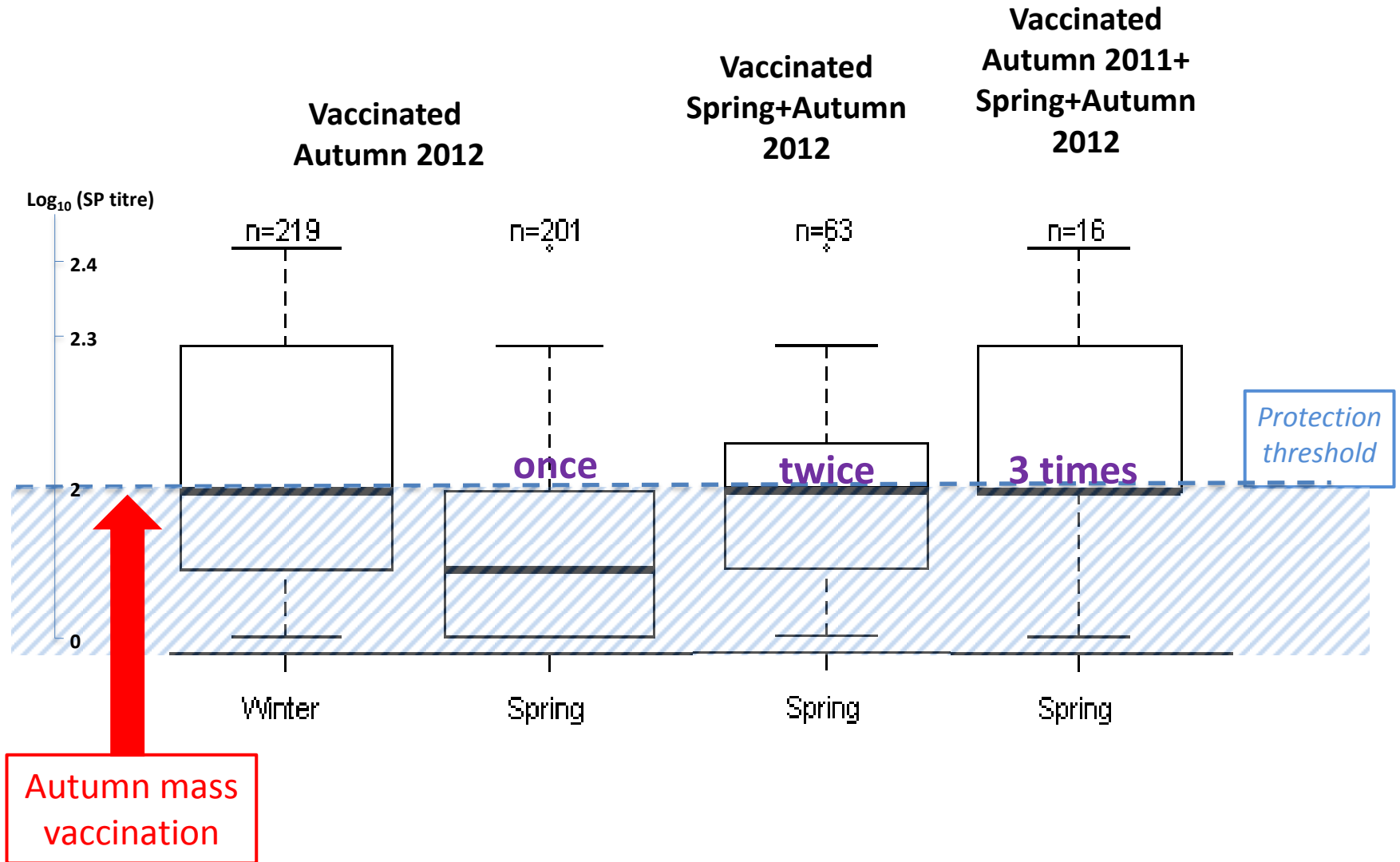
# Structure changes with births & deaths over the annual production cycle



New births = New unvaccinated animals

Population immunity is constantly changing with population turnover & declining antibodies

# Post-vaccination immunity also declines with time depending vaccine history



# If multiple doses needed, variation in immunity resulting from variation in coverage becomes exaggerated

If 3 doses needed for “adequate” protection

District with 100% coverage:

After 3 rounds: 100% of cattle vaccinated 3 times

District with 50% coverage:

After 3 rounds:  $50\% \times 50\% \times 50\% = 12.5\%$  vaccinated 3 times

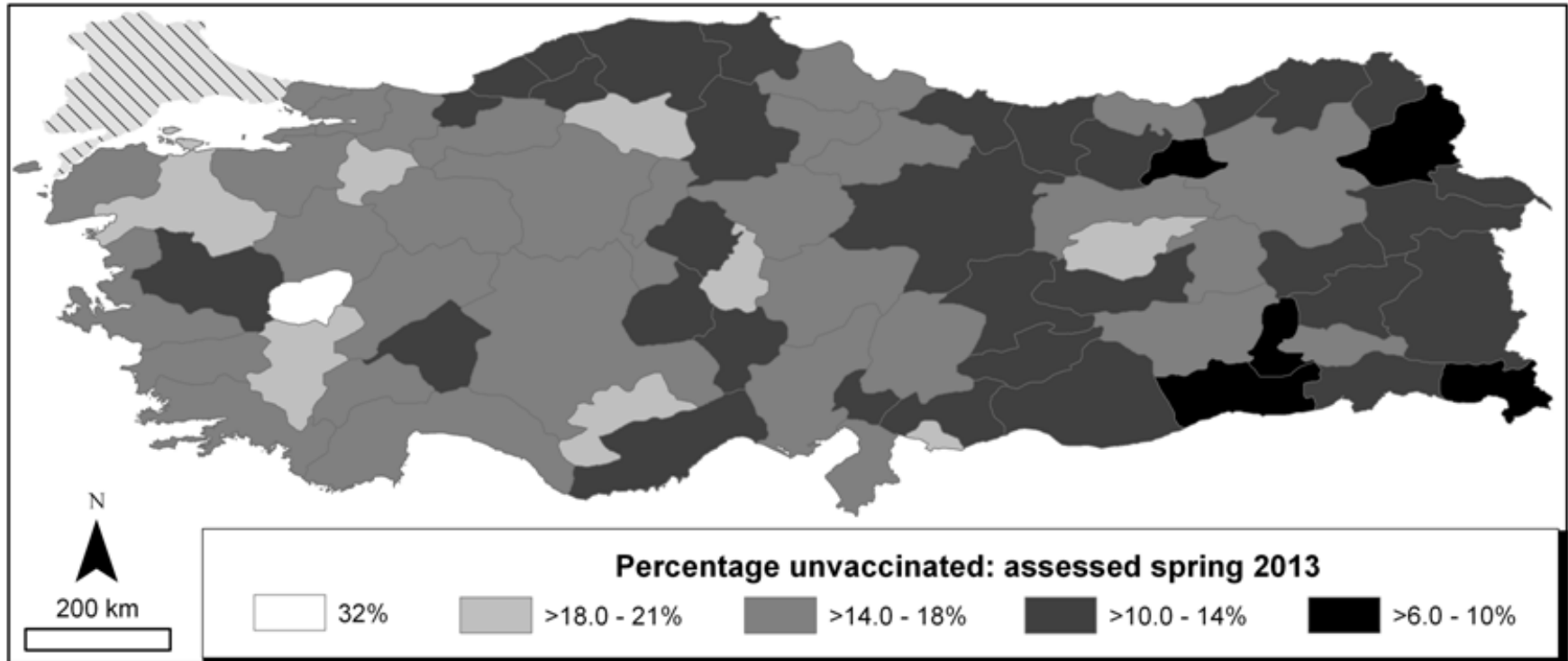


# Population coverage model

- Describe population immunity over the production cycle with 2012 Turkish mass vaccination policy
- Simulated the Turkish cattle population for each province
  - Age-structure by day and month of birth
    - Using data from national random surveys for each province and census data
- Dynamic population model representing the changing age structure for each province over the annual production cycle

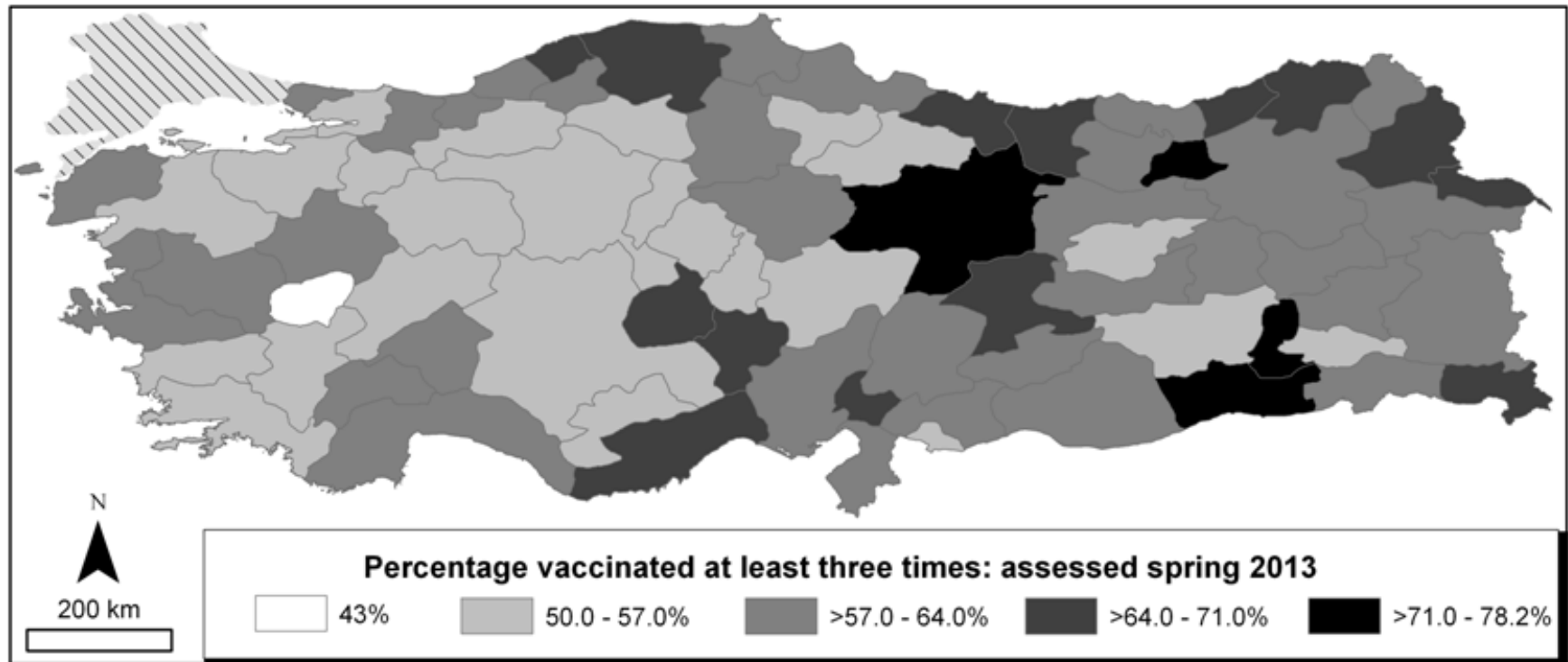
# Percentage never vaccinated 6 months after mass vaccination – if eligible cattle always vaccinated

*median values reported*



Unvaccinated = Cattle too young at prior vaccination  
+  
New births since prior vaccination

# Percentage vaccinated $\geq 3$ times in lifetime – if eligible cattle always vaccinated



Vaccinated  $\geq 3$  times = Adult cattle

## But not all eligible cattle will be vaccinated

Field studies and routine data found 40–99.9% vaccinated

Betapert distribution (minimum=40%, maximum=100%, most likely=80%)

### Results:

- Six months after the last round of vaccination almost half of the cattle aged  $\leq 24$  months remain unvaccinated
- Only 50% of all cattle would have been vaccinated more than once with the last dose received  $\leq 6$  months ago

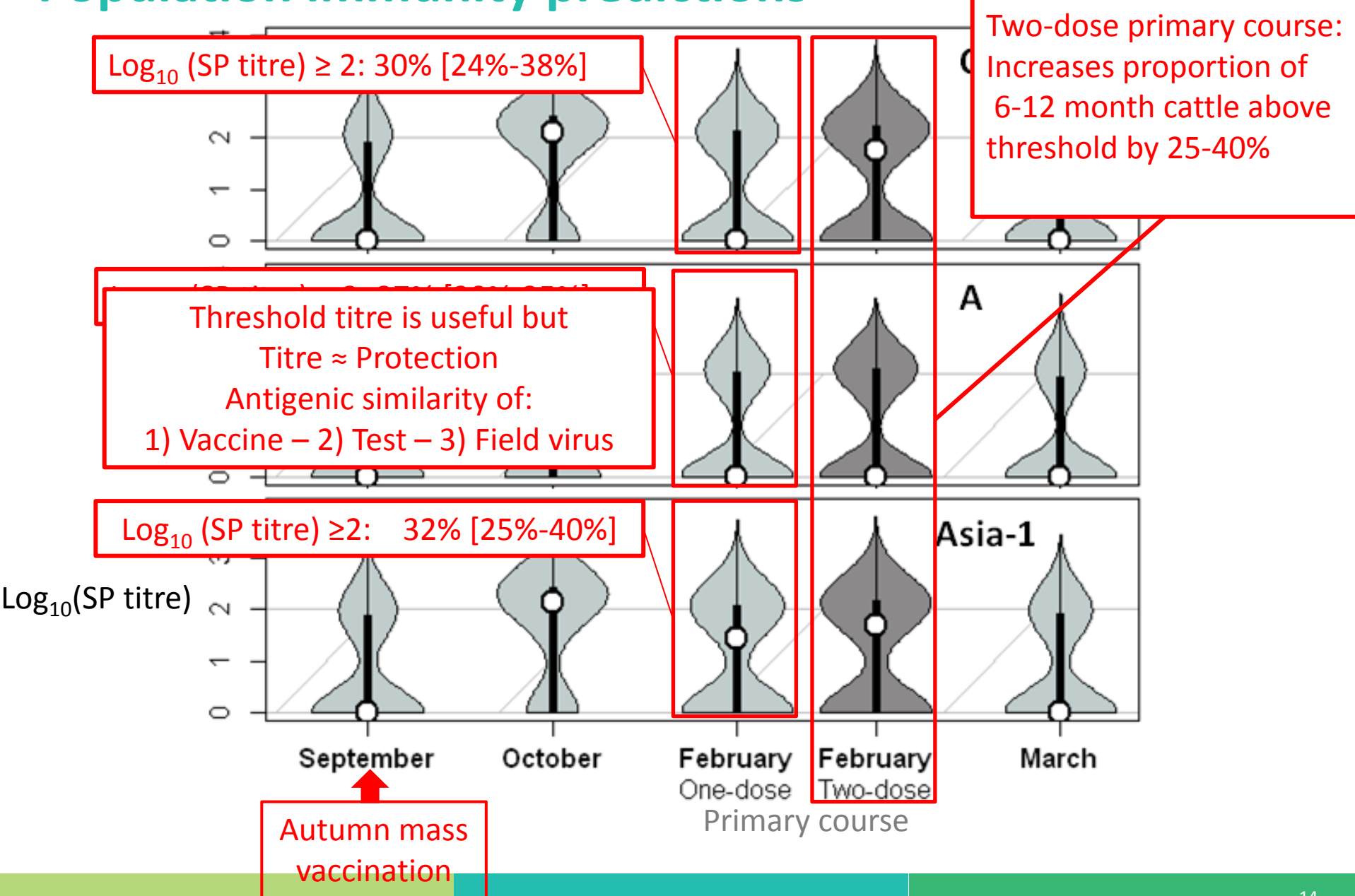
## From coverage to immunity

- Predict immunity for simulated population

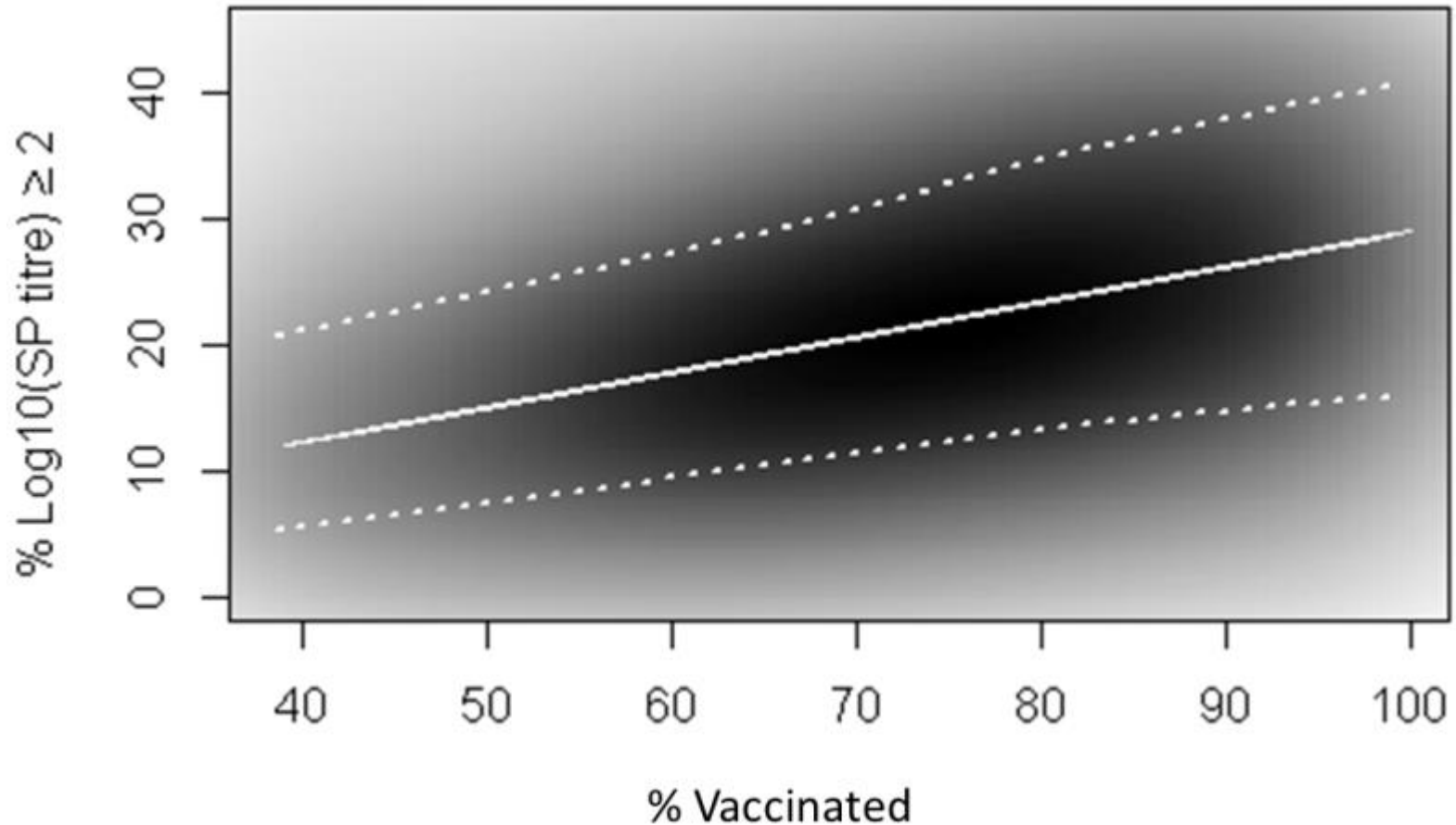
*LPBE SP titre = Time since vaccination + No. of times vaccinated*

- Using regression models fitted to data from extensive post-vaccination sero-monitoring study [n=647]

# Population immunity predictions



# District coverage and population immunity



Modelled proportion vaccinated in a district at autumn vaccination against the percentage of cattle with a serotype O SP titre  $\geq 1:10^2$  in mid February

# Sustained antibodies after single dose

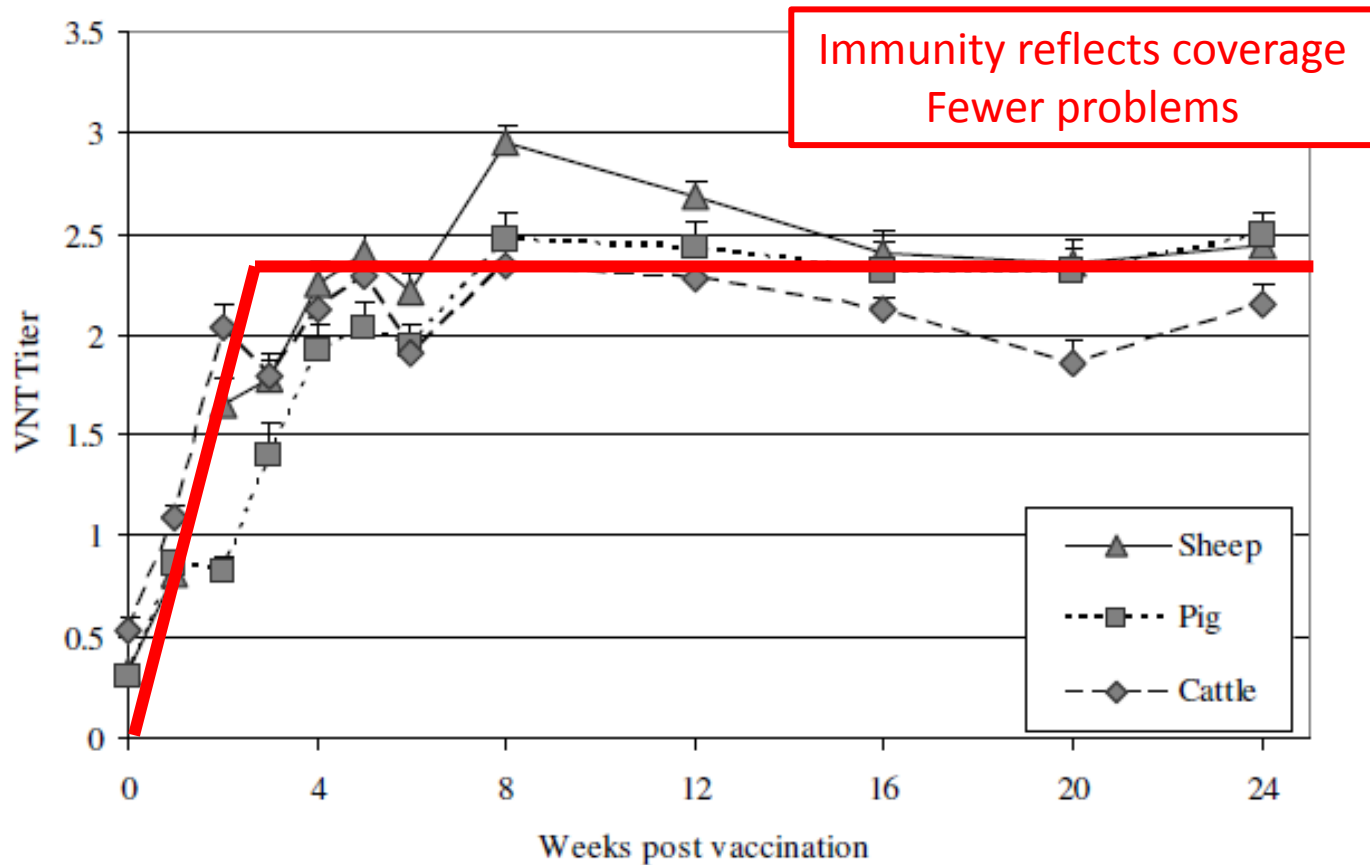


Figure 1. VNT (mean + sem) after vaccination with 6 PD<sub>50</sub> of O1 Manisa.

From: Selman P, Chénard G, Dekker A (2006) Cedivac-FMD; Duration of Immunity in cattle, sheep and pigs. Open session of the EuFMD, Paphos, Cyprus, 17-19 October 2006



## Conclusions: Mass vaccination in Turkey 2012

- Major immunity gaps despite biannual mass vaccination
- Improved vaccine required
  - $\geq 6$ PD50 vaccine now routine in Turkey
  - Two-dose primary course used in certain areas
- Immunity gaps will still exist
  - Each round of vaccination may exclude a quarter of all cattle
    - Often unavoidable
- Improved biosecurity measures required
  - Avoid over reliance on vaccine protection

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