FMD epidemiology

Transmission and disease dynamics

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Rio de Janeiro, Brazil, May 27, 2023

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NC STATE UNIVERSITY
COLLEGE OF VETERINARY MEDICINE

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Acknowledgement/Funding

NC STATE UNIVERSITY

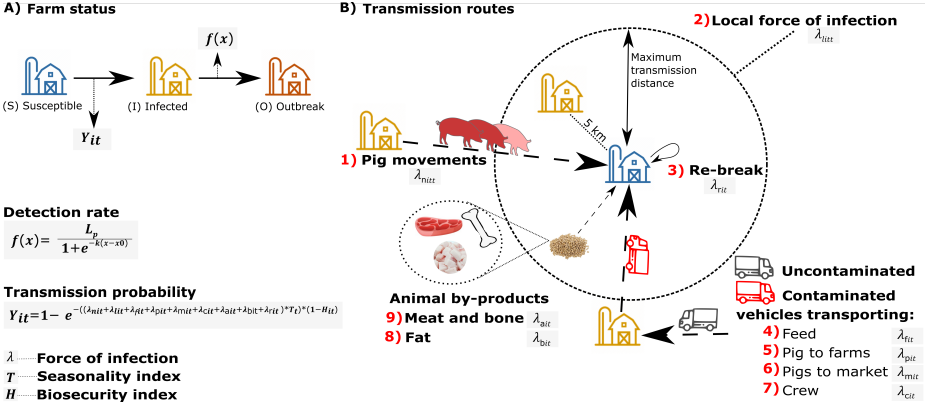
PANAFTOSA
Centro Panamericano de Fiebre Aftosa
y Salud Pública Veterinaria

Motivation

2000, FMD in Rio Grande do Sul, Brazil

Between-farm porcine epidemic diarrhea virus transmission dynamics

Modeling between-farm transmission dynamics of PRRSV.



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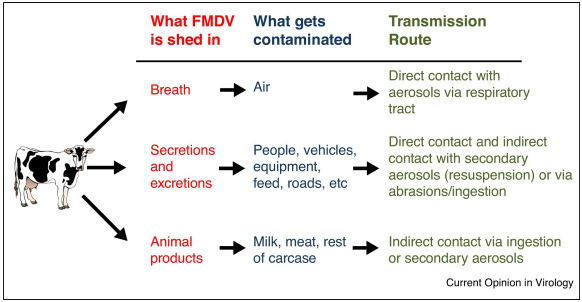
Revisiting foot-and-mouth disease epidemiology

FMD epidemiology

1. FMD affects cloven-hoofed animals (including cattle, sheep, goats and pigs).



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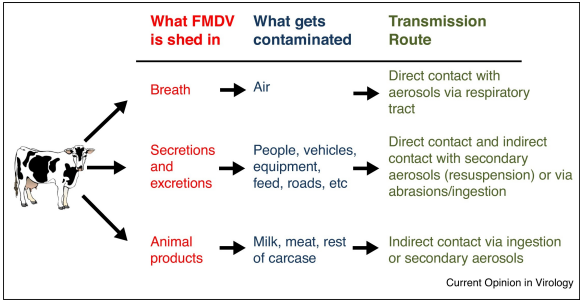

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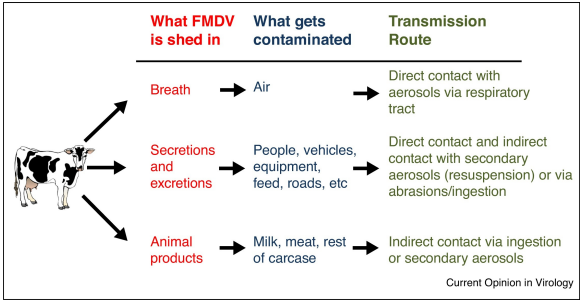

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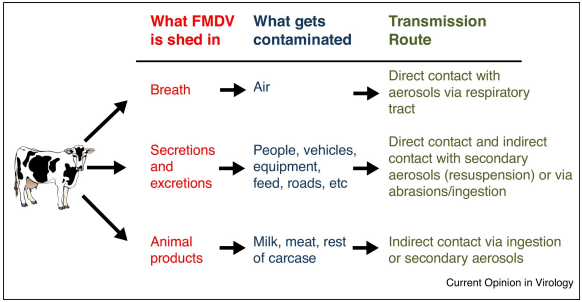

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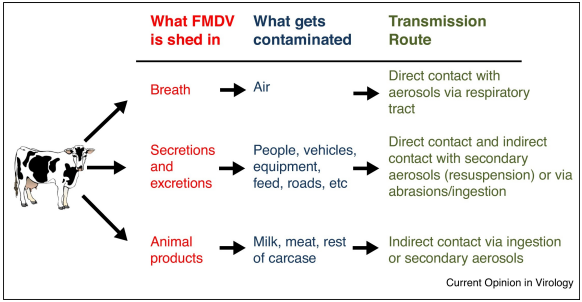

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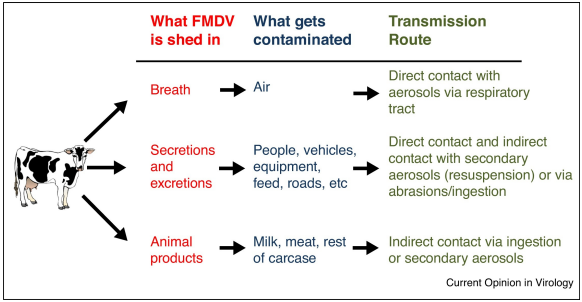

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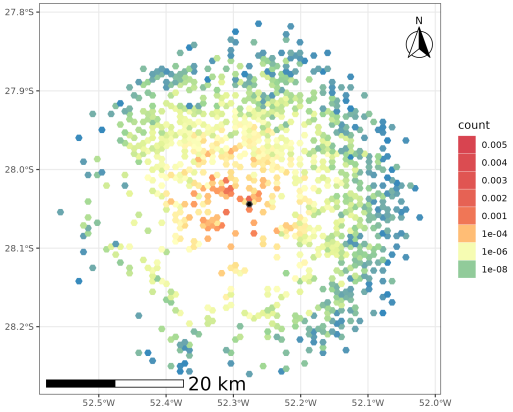
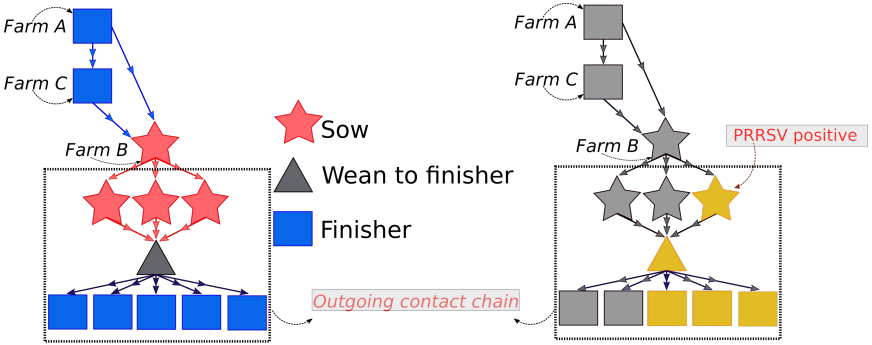
Local spread

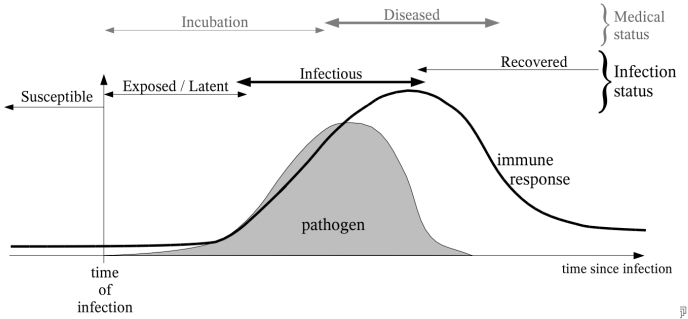


Between-farm movements



FMD transmission dynamics

1. Experimental studies under controlled conditions contributed to understanding parthenogenesis and transmission dynamics.



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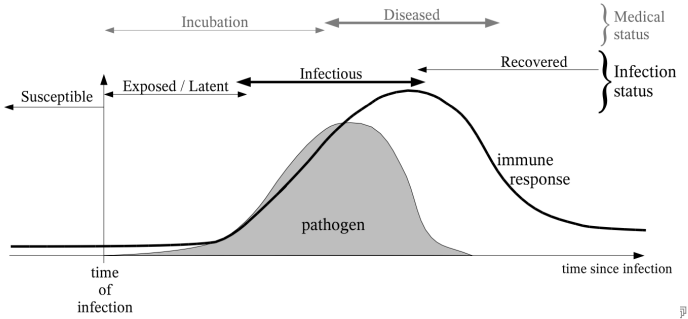

FMD transmission dynamics

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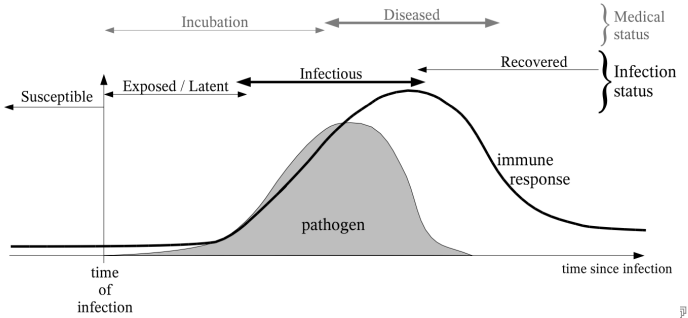
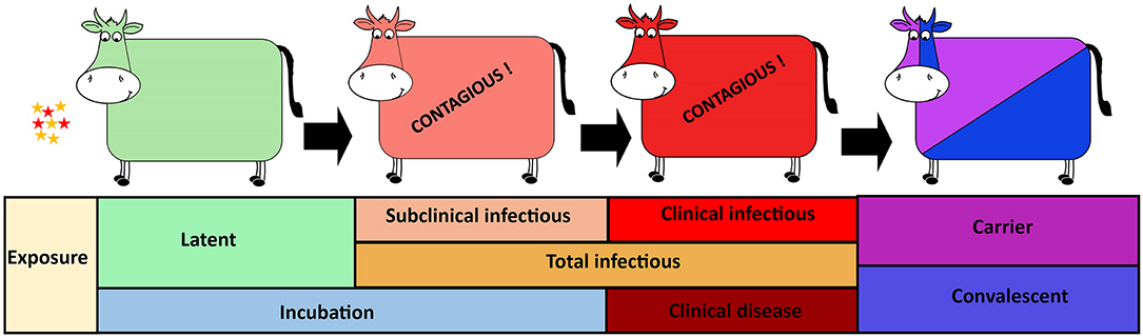
2. Small-scale studies cannot quantify low-probability transmission routes, e.g., fomites, contaminated feed, or carriers.
3. Ideally, we would need good data from real epidemic!!!



FMD progression cattle



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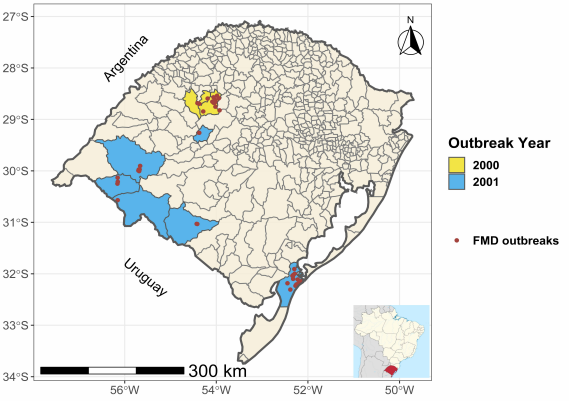
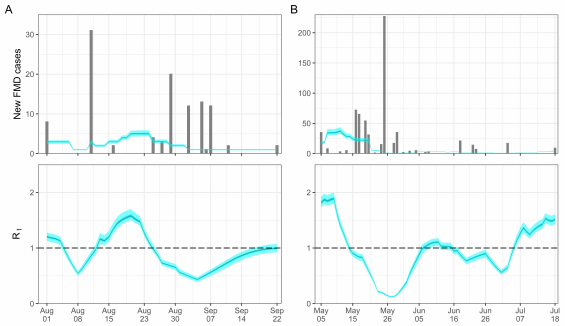
FMD transmission dynamics

We need good data from real epidemics!!! [1]

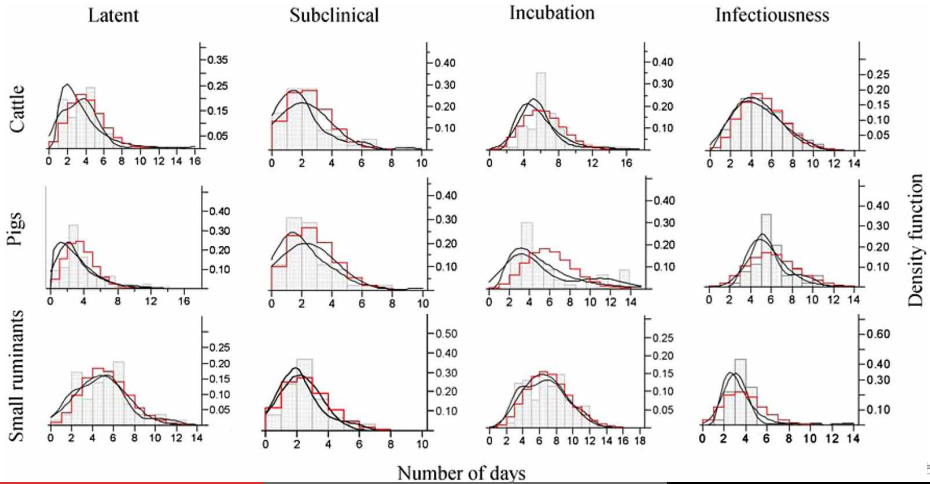




FMD transmission parameters

FMD progression cattle

If we are missing field data to estimate disease progress? meta-analysis? [4]



FMD progression

What do we do if are missing field data to estimate how the disease progress? meta-analysis? [4]

FMD stage	Animal species	No.	Mean, median (25th, 75th percentile)	Distribution (parameters)	Poisson (λ)
Latent	Cattle	136	3.6, 3 (2, 5)	Weibull (α = 1.782, β = 3.974)	3.59
	Pig	72	3.1, 2 (2, 4)	Gamma (α = 1.617, β = 1.914)	3.07
	Small ruminant	58	4.8, 5 (3, 6)	**Pert** (m = 3.963, a = 0, b = 13.983)	4.79
Subclinical	Cattle	119	2.0, 2 (1, 3)	**Gamma** (α = 1.222, β = 1.672)	2.04
	Pig	45	2.3, 2 (1, 3)	**Inverse Gaussian** (μ = 2.3, λ = 3.045)	2.27
	Small ruminant	62	2.2, 2 (1, 3)	Gamma (α = 2.4, β = 0.898)	2.16
Incubation	Cattle	59	5.9, 5 (5, 6)	Log logistic (γ = 0, β = 5.3, α = 4.02)	**5.9**
	Pig	46	5.6, 4 (3, 9)	Pearson 5 (α = 3.05, β = 11.72)	5.58
	Small ruminant	128	6.6, 6 (4, 8)	Weibull (α = 2.784, β = 7.426)	**6.59**
Infectious	Cattle	71	4.4, 4 (3, 6)	**Gamma** (α = 3.969, β = 1.107)	**4.39**
	Pig	53	5.7, 5 (5, 6)	**Log logistic** (γ = 0, β = 5.39, α = 5.474)	5.69
	Small ruminant	59	3.3, 3 (2, 4)	Pearson 5 (α = 6.188, β = 17.192)	3.32

The **process** of disease transmission is the core dynamic process in a transmission model.

Important parameters

- **Infectious period**: average period for an animal to be infectious.

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- **Generation time**: time for an infected individual to generate a second infection
- **Serial interval**: time between the onset of symptoms for an animal and the onset of symptoms for another second infected animal.

FMD and most disease control actions

We follow national and local control and eradication plans.

1. Vaccination.

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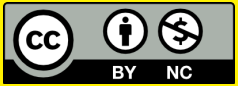
4. Control zones.

Thanks for listening

Questions?



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[1] Joao Marcos Nacif da Costa et al. “Assessing epidemiological parameters and dissemination characteristics of the 2000 and 2001 foot-and-mouth disease outbreaks in Rio Grande do Sul, Brazil”. In: *bioRxiv* (2022).

[2] Jason A Galvis et al. “Modeling between-farm transmission dynamics of porcine epidemic diarrhea virus: characterizing the dominant transmission routes”. In: *arXiv preprint arXiv:2201.04983* (2022).

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[3] Jason A Galvis et al. “The between-farm transmission dynamics of porcine epidemic diarrhoea virus: A short-term forecast modelling comparison and the effectiveness of control strategies”. In: *Transboundary and Emerging Diseases* (2021). DOI: *10.1111/tbed.13997*.

[4] Fernando Mardones et al. “Parameterization of the duration of infection stages of serotype O foot-and-mouth disease virus: an analytical review and meta-analysis with application to simulation models”. In: *Veterinary research* 41.4 (2010), p. 45.

[5] Shankar Yadav et al. “Parameterization of the durations of phases of foot-and-mouth disease in cattle”. In: *Frontiers in veterinary science* 6 (2019), p. 263.